Agriculture
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Canadian Grain Commission
Commission canadienne des grains

GRAIN RESEARCH LABORATORY

1985-1986 REPORT

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Cover Photograph
Glucosinolate analysis of rapeseed/canola in the Oilseeds Section — extracting the glucosinolates from defatted samples.

CANADIAN GRAIN COMMISSION
GRAIN RESEARCH LABORATORY

May 30, 1986

Canadian Grain Commission
Winnipeg, Manitoba

Commissioners:

I am pleased to submit the following report reviewing the activities of the Grain Research Laboratory for the period April 1, 1985 to March 31, 1986.

Respectfully submitted,

K.H. TIPPLES
Director

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DIRECTOR'S COMMENTS

The Laboratory's work during 1985-86 continued to be directed primarily toward two objectives: quality assurance for Canadian grain and oilseeds, and market support.

An increasing emphasis on the production and marketing of classes of wheat other than our major export grains has prompted the Canadian Wheat Board to seek the Laboratory's involvement in more market support activities. In particular, the introduction in 1985 of a new class of wheat, Canada Prairie Spring, designed to accommodate high-yielding varieties of medium hardness, medium protein content and medium gluten strength, has stimulated the Laboratory to develop an expertise related to a wider range of end-products than are normally associated with traditional Canadian bread wheats.

A late wheat harvest in 1985 made it very difficult to obtain representative samples for our new crop surveys, particularly of lower grade grain. In order to determine how well the various wheat classes withstood the adverse conditions, a number of "term" employees were hired to work on an extensive project to monitor the Falling Number of all wheat rail carlot deliveries to terminal elevators. In part, it is a tribute to our wheat breeders, especially Dr. A.B. Campbell, who developed the sprout-resistant variety Columbus, that the three milling grades of the Canada Western Red Spring wheat class came through the harvest remarkably well. Much grain from the 1985 harvest had to be artificially dried, either on farms, by custom operators or at terminal positions. Additional casual staff were hired for the Laboratory's testing service provided to dryer operators, to safeguard against damage to end-use quality.

Recent proliferation of unlicensed U.S. varieties in western Canada has necessitated a greater emphasis by the Laboratory on providing a varietal identification service, based on polyacrylamide gel electrophoresis (PAGE). This service is used by the Grain Inspection Division as a backup to their ability to distinguish varieties visually and so keep the various classes of Canadian wheat separate and free from admixture with unlicensed varieties of inferior quality. Concern with this subject has stimulated the Laboratory to intensify its research efforts to develop alternative non-visual varietal identification procedures.

In general, the Laboratory's research programs continue to seek a better understanding of what constitutes "quality" in cereal grains and oilseeds. Ongoing efforts are made to develop improved methods of quality analysis based, wherever possible, on rapid instrumental approaches. A summary of our research activities during the past year is presented in the body of this report.

In recognition of the increasing importance of oilseed crops, notably canola rapeseed, and the Laboratory's expanded responsibility in this area, this year's Annual Report contains a special article featuring the work of our Oilseeds Section.

K.H. TIPPLES
Director

1985 - 1986 REPORT
of the
GRAIN RESEARCH LABORATORY
59th Report

INTRODUCTION

This report summarizes the activities of the Grain Research Laboratory for the twelve month period April 1, 1985 to March 31, 1986.

Research generally focuses on learning what governs end-use quality in grain and determining how it can be accurately measured. In addition to outlines of the basic and applied research studies in progress or completed during the aforementioned period, brief descriptions of extensive special projects that arise from time to time are provided. Documented this year is work which was undertaken to help maintain the high quality of Canadian grain despite situations which developed due to adverse weather conditions during harvesting. Also described is the Laboratory's involvement in the Canadian grain variety licensing program for developing better quality cultivars for use in Canadian agriculture. A separate part of the report highlights the Oilseeds Research Section - covering its inception and past and present functions.

The liaison activities in which staff members participate may be grouped into several parts which are reported here as: membership on scientific and technical committees; attendance at meetings and conferences of professional associations; technical and consulting visits made; and visitors accommodated at the Grain Research Laboratory for various purposes including good public relations.

Another section lists the various periodical publications issued by the Grain Research Laboratory, and the research papers written by staff members and published in authoritative scientific and technical journals. Poster and oral presentations made at conferences and seminars are included.

The staff listing comprises the last part of the report.

AIM

The Grain Research Laboratory (GRL) functions within the terms of reference of Section 12 of the Canada Grain Act (1971) which indicates that the Canadian Grain Commission shall "undertake, sponsor and promote research in relation to grain and grain products and in so doing, maintain an efficient and adequately equipped laboratory." This research may be considered as having as its major objectives the quality assurance and market support for Canadian grain. The many programs involved in achieving these objectives may be broadly categorized as follows: an annual survey of the quality of the most recently harvested crop of several Canadian grains; a continuing survey of the quality of Canadian grain moving into export and domestic markets; an annual quality evaluation of plant breeders' cultivars of various grains, with regard to their potential for use in Canadian agriculture; and research undertaken to expand our understanding of what constitutes grain quality and to determine the quality characteristics required to enable Canadian grains to be utilized effectively within today's rapidly expanding technology.

To efficiently execute these programs, the Research Laboratory has a permanent staff of over ninety-five and is organized into fifteen sections headed by the persons shown.

Analytical Development and Services

P.C. Williams

The research aspects of the work in this section centre on the development of near-infrared reflectance spectroscopy (NIRS) methodology for the analysis of grain components and characteristics such as protein content, moisture content, oil content and kernel hardness. Ongoing functions include evaluating and calibrating NIRS instruments used in the Canadian wheat segregation system based on protein content; receipt, documentation and initial preparation of grain samples entering the GRL; and providing wheat and flour analysis services for all sections of the Research Laboratory. Typical analyses performed are ash content, starch damage, wet gluten content, gassing power, maltose value and fibre content.

Barley - Basic Research

The main objectives are the identification and characterization of barley and malt components that are important for end-use quality, with emphasis on documenting the physical and chemical changes that take place inside barley kernels during malting. Scanning electron microscopy is very useful for observing these changes as well as the differences in the internal structures of kernels of different barley varieties. The resulting increased knowledge leads to a clearer understanding of what constitutes good malting quality - thereby helping plant breeders develop barley varieties having improved malting characteristics.

A.W. MacGregor

In collaboration with barley breeders and animal nutritionists, studies are being made to evaluate feed quality varieties in order to improve their nutritional value.

Grain Biology and Malting Barley Applied Research

D.E. LaBerge

Research into malting technology leads to the development of new analytical procedures for barley and malt analysis. Micro-scale malting equipment is used to evaluate plant breeders' selections of malting barley entered in the Co-operative Six-Row and Two-Row Barley Tests. Pilot-scale equipment developed in the section is used for testing the most promising selections advanced to the final two years in the Co-operative Test. The pilot-scale testing is part of a collaborative trial involving domestic malting and brewing companies and the Brewing and Malting Barley Research Institute.

The grain biology unit investigates visual abnormalities detected in Canadian grain. In collaboration with the Inspection Division of the Canadian Grain Commission, an illustrated manual is being prepared and will document the appearance, cause and effect on quality of degrading factors in the Canadian grading system. The mycology unit deals with the detection and identification of fungi present in Canadian grain and the examination of the effects of their presence on seed.

Barley - Varietal Identification

B.A. Marchylo

The primary objective of this section is to develop a chemical method for the rapid identification of varieties in order to provide a more objective and reliable alternative to the current visual technique. Additional undertakings include research into providing a better understanding of the relationship between protein constituents and quality, and research into the physico-chemical characteristics of the technologically important enzyme alpha-amylase.

Breadwheat Quality Studies

K.R. Preston

Determining the baking quality of different classes and grades of Canadian wheat is the main service function of this section. Emphasis is on testing export cargo, new harvest and plant breeders' samples. Research activities are aimed at attaining increased knowledge of the baking process and the functionality of wheat flour components; and developing prediction and screening tests for baking quality.

Breadmaking Research

R.H. Kilborn

Projects are initiated to investigate changes or innovations in the commercial baking of bread and to determine how these trends relate to the baking quality of Canadian standard and experimental wheat varieties. This requires in-depth studies of the various aspects of the baking process - including mixing, fermentation, machining of dough, proofing and baking.

Specialized equipment is designed and constructed to facilitate the study of the principles of the baking process and the parameters associated with specific stages in a particular baking method.

Durum Wheat and Publications

R.R. Matsuo

Aid is given to the Inspection Division of the Canadian Grain Commission in maintaining the high quality of Canadian durum wheat by ensuring that tolerance levels for various grading factors accurately reflect end-product quality, and by monitoring the quality of carlots unloaded at terminal elevators and cargoes exported from Canada.

The promotion and sale of Canadian amber durum wheat is aided in several ways: by generating and publishing quality information on exported cargoes and on the most recently harvested crop; by collaborating with plant breeders to improve the overall quality of durum wheat cultivars to enable Canada to keep its share of the international market; by maintaining personal contact with semolina millers and pasta processors to keep abreast of technological advances and to generate good will for the Laboratory in the industry.

In certain parts of Asia, noodles are produced from wheat other than durum. The marketing of Canadian wheat which can be used in the manufacture of this type of noodle is aided by acquiring expertise in noodle quality evaluation and by providing to potential importers quality data on the suitability of various Canadian wheat classes for noodle production.

The Research Laboratory issues several periodical publications which detail the quality of export cargo and new crop samples of Canadian grain and which are distributed internationally. The publications unit provides the graphics, photography and editorial support required for publishing these quality data bulletins. Support is also provided for Laboratory staff in publishing research papers in scientific and technical journals.

Flour Milling

J.E. Dexter

The milling section is responsible for milling all wheat samples for the Grain Research Laboratory wheat quality testing program. A priority is the development of laboratory-scale procedures that result in milled products comparable in yield and quality to those from commercial mills. Current emphasis is on improving milling procedures for soft wheat and for wheat of the new Canada Prairie

Spring class.

Research into all aspects of milling technology is conducted, with the pilot-scale mill providing a vital link between experimental and commercial milling techniques. The section is also active in support of Canadian Wheat Board market development programs by providing information on the commercial milling potential of Canadian wheat for both domestic and foreign users.

Laboratory Services

C.J. Dempster

This section maintains the Research Laboratory's bi-weekly check test program for monitoring the performance of all Model 919 grain moisture meters used at Canadian Grain Commission locations throughout Canada. Meters are serviced, repaired and calibrated as necessary, and calibration equations verified or updated to ensure that sufficiently accurate results continue to be obtained. The determination of moisture content by the appropriate oven procedure is performed on samples submitted by the Inspection Division. Research into the determination of moisture content focuses on the evaluation of newly-introduced testing methods and instruments.

The biometrics and data processing unit provides statistical consulting services for the Laboratory to help ensure that sound experimental designs and sampling plans are used and that appropriate statistical analyses are correctly conducted and interpreted. Provision of training in statistical analysis and electronic data processing techniques to Laboratory staff is also the responsibility of the biometrician. Data processing activities include the development and updating of grain quality computer data bases and the preparation of reports dealing with the quality of domestic and export movements of grain.

Machineshop services include the maintenance, repair and fabrication of replacement parts for mechanical and electrical equipment - thus helping to keep all sections of the Laboratory functioning as smoothly as possible.

Oilseeds

The oilseeds section is responsible for monitoring and reporting on the quality of oilseeds grown in Canada. In conjunction with the monitoring program, research is carried out in projects designed to relate seed and product quality factors and to develop new and improved methods for measuring quality parameters.

Support is also provided to plant breeders by testing and reporting on the quality aspects of newly-developed varieties. Although the largest proportion of the analyses performed is done on rapeseed and canola, monitoring programs and research projects have also been performed on flaxseed, soybeans, sunflower seed, mustard seed and safflowerseed.

J.K. Daun

Residue Analysis

T.W. Nowicki

Since a high level of awareness and concern exist today over possible adulteration of food with agricultural pesticides and toxic metabolites of molds, the Research Laboratory maintains an elaborate residue testing capability to assist the Canadian Grain Commission's Grain Inspection Division in preventing grain contaminated with these compounds from entering food and export channels. Further to this, export cargo loadings of Canadian grains, including oilseeds, are monitored for the presence of objectionable levels of pesticides and mycotoxins.

Wheat Chemistry

R. Tkachuk

Research projects are initiated to help enlarge the body of knowledge on the chemistry of wheat quality. Particularly important in this regard is progressively attaining more comprehensive information on the structure and behaviour of proteins and other complex molecules and their relation to end-use quality. The enormous amounts of information yielded by sophisticated electrophoresis techniques in the separation of wheat proteins are analyzed using computer technology.

Wheat Enzymes

Basic research into wheat germination and enzyme biochemistry is performed to identify the enzymes present in both sound and sprouted wheat and to characterize the mechanisms involved in their actions on substrates. The evolution of improved methods for measuring the activity of alpha-amylase and other enzymes is an important consequence of this research. Projects are also aimed at: developing high performance liquid chromatography techniques for

J.E. Kruger

varietal identification purposes; and developing end-use quality tests for the evaluation of foreign-style baked goods produced incorporating Canadian wheat.

Wheat-Varietal Identification

V.J. Mellish

To help ensure that the concentration of unlicensed varieties in samples of Canadian wheat does not exceed the upper limit for a particular grade, a chemical identification procedure is being used to detect their presence. Electrophoresis of the gliadin protein fraction with subsequent analysis of the resulting distinctive band pattern is the technique used to verify the accuracy of visual separations of unlicensed varieties in carlot and cargo samples of Canada Western red spring wheat made at the Grain Inspection Division of the Canadian Grain Commission.

Administration

D.E. Routley

In addition to the ongoing function of providing clerical and secretarial support for all sections of the Research Laboratory, the major responsibilities of this section include the long-term planning aspects of financial and personnel management. To help achieve these aims efficiently with a favorable cost-benefit ratio, the section has kept abreast of current technology by acquiring computer-based office equipment.

CURRENT STUDIES

COMMON WHEAT

Influence of Irrigation on Dough Strength. A three-year study into the influence of irrigation practice on the quality of CWRS, CPS and CWSWS wheat has shown that farinograph stability decreases as the degree of irrigation increases, with CPS wheat exhibiting the greatest response. Similar but less dramatic effects were observed in Remix method baking test data for the CWRS and CPS samples - the reductions in loaf volume being more commensurate with protein content.

Effect of Prebreak Conditions on the Milling Performance of Some Canadian Wheats. The effects of prebreak roll surface (smooth vs corrugated), release and differential on the milling performance of some Canadian wheats of varying hardness were investigated using the GRL 10-inch experimental mill. The major benefit realized from a prebreak was a significant reduction in flour ash content - allowing flour yield within specified ash content tolerances to be increased. Generally, smooth rolls imparted a greater effect than corrugated rolls.

Effects of Midge Damage on Red Spring Wheat Quality. The wheat blossom midge infected hard red spring wheat fields in localized areas in both 1984 and 1985. Studies were undertaken to assess the damage caused by midge larvae in commercial wheat samples and in wheat from controlled experiments (carried out by Dr. R.E. Elliot, Agriculture Canada, Saskatoon) in which various insecticide treatments were applied to infested plots. The factors involved in the damage to end-use quality are complicated, but are believed to involve some sort of change in the gluten proteins - the very high protein content samples exhibited the greatest reduction in baking performance.

Assessment of the Quality of Canadian Wheat Flours in the French Baking Industry. Five Canadian wheats (No. 1 CWRS-13.5, No. 1 CU, No. 1 CWRW, No. 1 CPS and BW 15) were milled on the GRL pilot mill into straight-grade flours and tested alone or in blends (4%, 8% and 12% French domestic flour) to produce baguettes and batards. The results indicate that Canada Western Red Winter wheat is the best overall choice for the production of traditional French bread, with No. 1 CWRS and No. 1 CU wheats probably the best choices for blending.

The Potential of Various Canadian Wheats for the Brazilian Market. A milling procedure was developed for the Grain Research Laboratory pilot mill to produce a flour of comparable extraction and quality to Brazilian flour. When milled as mixed grist with a representative Brazilian wheat composite, Canadian wheats (classes CWRS, CPS, CWRW and CU) all extended flour extraction rates. Results of baking tests performed to date indicate that both Remix-method pan bread and hearth bread quality is improved by using flour produced from each of the mixed grists.

Evaluation of Canada Prairie Spring and Canada Western Red Winter Wheats for Use in Egypt. Results from a joint Grain Research Laboratory, Canadian International Grains Institute and Egyptian government testing program indicated that both Canada Prairie Spring and Canada Western Red Winter wheat are suitable for the Egyptian market. Wheats were milled on the CIGI pilot mill.

Egyptian "shami" bread produced from Canadian wheat flour.

Reversed-phase High-performance Liquid Chromatography (RP-HPLC) as a Possible Method for Wheat Cultivar Identification. RP-HPLC is being evaluated as a possible method for the rapid chemical identifica-

tion of wheat varieties. Initial indications are that the method shows potential, and further evaluation is continuing.

Electrophoretic Verification of and Monitoring for Unlicensed Varieties in Canadian Wheat. Gel electrophoresis is being used to chemically verify the accuracy of visual separations of unlicensed varieties in carlot and cargo samples of red spring wheat made by the Canadian Grain Commission's Grain Inspection Division. Analysis resulted in the grades of 23 carlots being lowered because grade limits for unlicensed varieties were exceeded.

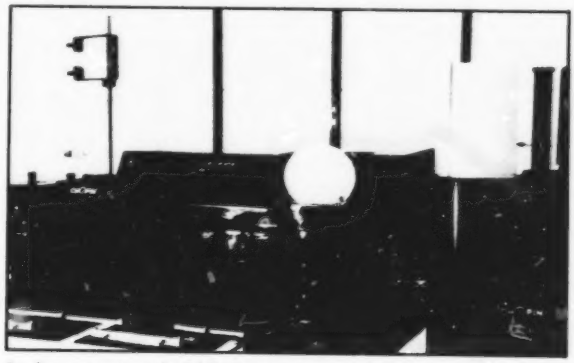
Two-dimension (2-D) Electrophoresis and Wheat Cultivar Identification. Preliminary studies have been carried out using various 2-D electrophoresis procedures for the separation of wheat proteins. This technique yields more information than any other presently-used procedure in wheat cultivar identification; and clear gel-map differences are produced for cultivars which are very difficult or impossible to positively identify when using 1-D electrophoresis. However, the amount of data present in 2-D maps is so large and complex that appropriate image-analysis techniques will probably need to be used to fully and properly analyze the information.

Development of a Near-infrared Index (NIRI) for Wheat Hardness. Since the hardness of wheat greatly affects the particle size distribution of the meal produced when it is ground and since the near-infrared spectroscopy (NIRS) technique is very sensitive to fluctuations in particle size, shape and distribution of the ground material presented to the instrument, a study into the possibility of determining wheat hardness by NIRS was undertaken - with the resulting development of a near-infrared index for this parameter. The NIRI ranges from 0 to 100 units, with the harder types of wheat (e.g., Durum) having the higher values.

Determination of Wheat Strength by Near-infrared Reflectance Spectroscopy (NIRS). A set of hard red spring wheat samples having a small range in protein content and hardness but a large range in baking strength (in terms of farinograph stability and Remix loaf volume) was analyzed by NIRS. A statistical examination of the results revealed correlation coefficients of 0.85 for NIRS versus farinograph stability and 0.90 for NIRS versus loaf volume - considered satisfactory for enabling NIRS to be used for identifying promising lines in a breeding program.

Influence of Derivative Size of NIRS Values in Determining the Protein Content of Wheat. Derivatized versions of the raw log 1/R signal recorded by NIR instruments have been found to improve the accuracy and precision of the determination of protein content in wheat. Optimum derivative sizes were 15 points for the first derivative and 10 points for the second derivative.

Effects of Starch Damage and Water Absorption on the Alveogram Properties of Canadian Hard Red Spring Wheat Flour. Analysis of test results for three hard red spring wheat flours milled on the GRL 10-inch experimental mill to low, normal and high levels of starch damage showed significant positive linear relationships for starch damage versus alveogram pressure and work, and significant negative linear relationships for starch damage versus alveogram length and swelling index values. Opposite results were obtained for the relationships between dough water level and these same alveogram properties.



A characteristic bubble being generated during the alveograph test.

Effect of Smooth-roll Grinding Conditions on Reduction of Hard Red Spring Wheat Semolina. A roll stand of the GRL 10-inch experimental mill was used to examine the effects of feed rate, roll velocity and roll differential. Increasing the roll velocity or reducing the feed rate resulted in increased flour release and milling energy requirement, as well as improved flour ash content and flour color. Increased roll differential led to increased flour starch damage, flour ash content and milling energy requirement, and to poorer (darker) flour color.

AMBER DURUM WHEAT

The Role of Lipids in Spaghetti Cooking Quality. Since the non-polar lipids of semolina influence the surface stickiness of cooked spaghetti, the possible effects of other lipids was investigated. The use of sunflower seed and coconut oils had no effect, whereas monoglycerides decreased surface stickiness and improved tolerance to overcooking. Evaluation of a rapid method incorporating color measurement of the iodine-amylose complex to estimate surface stickiness and cooking loss indicates that the technique is promising.

Effect of Artificial Drying of Durum Wheat on Spaghetti Quality. The farinograph test has traditionally been used at the Grain Research Laboratory to detect quality damage in artificially dried samples of durum wheat. However, it is now believed that farinogram characteristics may not be closely related to spaghetti cooking quality, and therefore quality testing of spaghetti made from artificially dried durum wheat is being conducted.

Relationship Between Durum Wheat Vitreosity and Hardness. A visual estimation of the hard vitreous kernel content is the current method used to assess the starchiness of Canadian durum wheat samples. Since this procedure is highly subjective, the use of kernel hardness measurements is being considered as a possible alternative. Both the particle size index and near-infrared hardness index tests are being evaluated for this purpose.

The Effect of Wheats of Other Classes on Durum Wheat Quality. A study was initiated to determine the influence of admixtures of wheat of class Canada Western Red Spring (CWRS), Canada Western Red Winter (CWRW), Canada Prairie Spring (CPS) and Canada Western Soft White Spring (CWSWS) with Canadian amber durum wheat on semolina milling yield and spaghetti quality. Results of milling experiments revealed that admixtures of the CPS and CWSWS samples were more detrimental to semolina yield than the harder CWRS and CWRW samples. Quality of spaghetti produced from the various admixture samples is currently being evaluated.

Effect of Test Weight on Durum Wheat Milling and Spaghetti-making Quality. Ninety composite samples ranging in test weight from 74 to 83 kg/hL were milled into semolina and subsequent linear regression analysis of the results yielded correlation coefficients of 0.73** (1985 harvest survey samples) and 0.68** (1984 harvest survey samples) for semolina yield versus test weight. The relationship was linear throughout the entire range of test weight. Both semolina ash content and Agtron color value were also adversely affected by declining test weight, leading to spaghetti having poorer color. The lone benefit arising from lower test weight was improved cooking quality; but this was far outweighed by the previously-mentioned detrimental factors.

Spaghetti being extruded during processing in the durum wheat testing laboratory.

BARLEY

Focusing Properties of Beta-amylase Enzymes of Barley and Malt. Recent evidence suggests that barley contains two distinctive forms of "bound" beta-amylase. When "bound" beta-amylase extracted by thioglycerol was treated with purified papain, the isoelectric focusing properties of the resulting product were identical to those of beta-amylase obtained from malt. Treatment of barley grist (previously extracted with thioglycerol until no further beta-amylase activity was evident) with purified papain resulted in the release of a substance having apparent pI values identical to those of beta-amylase found in malt.

Alpha-glucosidase in Barley and Malt. Activity of a maltose-degrading enzyme (detected in the pericarp tissue of immature barley) increased for up to 8 days after anthesis and then decreased as the kernels matured. A similar enzyme was detected in the scutellum of germinated barley.

Limit Dextrinase in Barley and Malt. A specific assay for limit dextrinase has been developed and will be used to study factors affecting the formation of this enzyme during barley germination.

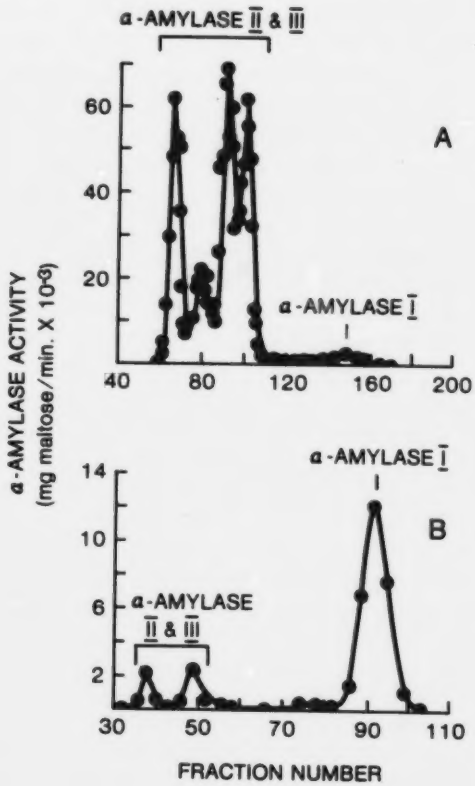
Studies on Hordein Proteins Produced During Malting. Reversed-phase high-performance liquid chromatography and sodium dodecyl sulphate gradient gel electrophoresis were used to study hordein proteins produced during malting of two barley variety samples exhibiting contrasting malting quality. Significant differences were found in the extractability of the storage proteins.

Frosting Studies. Three mobile refrigerated chambers were used to systematically freeze portions of a field of Bonanza barley grown at the Agriculture Canada Glenlea Research Station. The plots were frosted at a temperature of -3°C for a period of 4 hours, and the frosting was done at various stages of barley maturity - ranging from floral anthesis to harvest ripeness. Sufficient material was obtained to prepare 7 samples of barley frosted at various stages of kernel development. Pilot-scale malting and brewing trials will be conducted on these samples.

Portable freezing units being used to frost barley in the field.

Alpha-amylase Studies. As part of ongoing studies on barley and malt alpha-amylases, products formed during hydrolysis of amylose by malt alpha-amylase have been determined quantitatively. Based on these results, a model has been proposed to describe the hydrolysis of soluble starch by cereal alpha-amylases.

Production of Alpha-amylase in Excised Barley Embryos. Alpha-amylase produced in excised barley kernels was studied to obtain further information about its control and production in germinating cereal grains. The study provided further quantitative evidence that the embryo can synthesize significant amounts of this enzyme.



A. Alpha-amylase components in germinated barley kernels.
B. Alpha-amylase components in incubated barley embryos.

OILSEEDS

Chlorophyll in Rapeseed and Canola. From a joint study with the Canola Council of Canada, it was found that environmental factors accounted for most of the yearly interlocational variation in the chlorophyll content of rapeseed. Agronomic practices which tend to reduce chlorophyll levels include: early planting date, a growing period of at least 95 days, and a seeding rate greater than 5 pounds per acre. To date, experiments have shown no relationship between seed storage period and chlorophyll content.

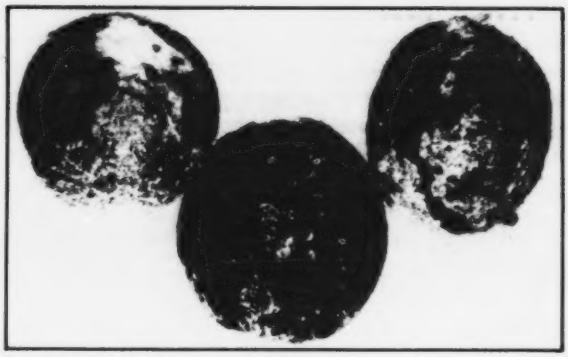
Assessment of Oilseed Sunflower Maturity. Samples of seed from hybrids grown at different locations were taken at various times prior to harvesting and assessed for moisture content, oil content, protein content and fatty acid composition. The results from these tests will be compared with data from the currently-used visual evaluation method for estimating maturity, the aim being an attempt to establish a more objective means of determining this characteristic.

Glucosinolate Measurement in Canola and Rapeseed. Since the method currently used at the Grain Research Laboratory for measuring the glucosinolate content of rapeseed is time-consuming and expensive, a more rapid technique has been developed and recommended to the oilseed industry for use in quality control.

Quality Factors for Confectionary Sunflowerseed Varieties. Commercial users of confectionary seed were surveyed to determine the quality factors which should be considered in the evaluation of hybrids for possible licensing. Large seed size, high test weight, black and white hull

coloration and high seed meat content were identified as desirable quality characteristics. All confectionary hybrids tested met these suggested criteria, although two distinct seed size groupings were noted. The larger seed would be suitable for the edible market, while the smaller seed would be suitable for the birdseed market.

Quality of Canola and Rapeseed Harvested After Overwintering in Northern Alberta. Samples of fall-harvested and spring-harvested seed from the same growing area were analyzed for quality. The oil content and protein content were higher for spring-harvested seed, but it also exhibited the detrimental factors of higher acidity and conductivity and lower viability. As well, the spring-harvested seed did not store as well, displaying larger increases in acidity, conductivity and storage fungi and larger decreases in seed viability.



Spring-harvested rape/canola seeds exhibiting a crusted, blistered and peeling surface layer.

RESIDUE ANALYSIS

Pesticide Residue Analysis Methodology. Screening and confirmation of suspected seed treatment pesticides on stained kernels found in carlot deliveries to terminal elevators are now being performed using mass selective detection (MSD) capillary column gas chromatography. This approach has proven to be faster and more reliable than methods employing various combinations of conventional gas chromatography detectors and packed columns and the use of chemical derivatization for confirmatory purposes. An MSD technique has also been developed to confirm suspected positive results for ethylene dibromide obtained by electron capture detection gas chromatography.

Mycotoxin Residue Analysis Methodology. The development of an analytical method incorporating capillary gas chromatography with mass selective or electron capture detection now allows the major trichothecene mycotoxins (vomitoxin, T-2 toxin, HT-2 toxin and diacetoxyscirpenol) associated with *Fusarium* infections in grain to be screened simultaneously.

Screening for *Fusarium* Trichothecene Toxins in Wheat Containing "Tombstone" Kernels. A total of 58 samples of wheat harvested in 1985 and suspected of containing "tombstone" kernels were submitted by elevator managers and producers for testing. Vomitoxin was found to be present at levels of 0.05 ppm or over in 44 of the samples, with 5 samples exhibiting a concentration over 1.00 ppm. The highest concentration recorded was 3.65 ppm. A trace amount of HT-2 toxin was found in one sample, and none of the other toxins were detected.

Screening for *Fusarium* Trichothecene Toxins in Ontario Corn. Vomitoxin was detected in all 24 samples of 1985-grown Ontario corn submitted by the Grain Inspection Division - at concentrations over 2.00 ppm in 6 samples and over 5.00 ppm in 3 samples. Very low concentrations of HT-2 toxin were detected in two samples and of T-2 toxin in one sample. Diacetoxyscirpenol was not detected.

Asci, ascospores and conidia of *Gibberella zeae* (Schw.) Petch, also known as *Fusarium graminearum* Schwabe. A pathogen of corn, it is capable of producing mycotoxins such as deoxynivalenol (vomitoxin).

OTHER TOPICS

Mycology Studies. Sixty-two wheat samples, selected from primary elevators in Manitoba on the basis of the presence of "tombstone" kernels, were analyzed for the presence of *Fusaria* - with the two most common species found being *F. graminearum* (present only in samples from southeast Manitoba) and *F. sporotrichioides*. Studies into the mycoflora associated with mildew in red spring wheat revealed differences related to geographical location in the observed frequency of a number of genera and species. A comparison of the mycoflora of canola and rapeseed harvested both in the autumn and after overwintering revealed that higher initial levels of field-fungi were present in the "overwintering" samples. Storage studies, with storage at various moisture content levels for up to 30 days, showed that storage mold levels increased to a greater extent in the "overwintering" samples as well.

Examples of "tombstone" wheat. The three diseased specimens on the right show the effects of *fusarium* infection — light weight kernels with a shrunken, chaulky appearance.

Microscopy Studies. The internal structure of midge-damaged kernels of red spring and amber durum wheat was found to be shrunken but sound since no degradation of aleurone layer was detected. Folds were observed in the aleurone layer, and in many instances the pericarp had a loose, sponge-like appearance. Extensive degradation of the protein matrix, cell wall and starch granules was evident in the damaged areas of wheat and barley kernels deemed to have suffered "sucking-insect damage". These degraded areas were similar in appearance to the endosperm structure of germinated wheat and barley, while the undamaged parts of the kernel appeared to be quite sound. Examination of rye kernels exhibiting grasshopper damage showed that, in general, the protein matrix and cell wall material had undergone degradation but that the starch granules, although exposed, were undamaged. In addition, fungal mycelia were often present on the exposed endosperm surfaces.

The Fate of Deoxynivalenol (DON) During the Processing and Cooking of Spaghetti and Noodles. Results of milling tests on samples of amber durum and Canada Western red spring wheat (both confirmed as containing DON toxin) confirmed previous reports that DON is not destroyed during milling, although flour DON levels were much lower than millfeed DON levels. Although processing into noodles and pasta had no influence on DON levels, 50% of the DON was removed during cooking - with all of this decrease accounted for by the increased presence of DON in the cooking water. The level of DON in Chinese-type noodles (alkali included in dough during processing) following cooking was significantly less than that found in cooked Japanese-type noodles.

Grain Biology Studies. Kernel and seed appearances resulting from a wide variety of influences were characterized in samples from the 1984 and 1985 crops of several grains. Effects studied include: grasshopper damage, midge damage, wheat head army worm damage and suspected lygus bug damage in some cereals; physical damage to rapeseed harvested after overwintering; suspected fungal infections (verified by mycological analysis in the mycology section) - particularly in pink-colored kernels in samples of the red spring wheat variety Columbus. In most instances, the cause of the pink discoloration appeared to be a natural pigment associated with immaturity.

Kernels of rye which have been chewed by grasshoppers, army worms or cutworms.

SPECIAL STUDIES

In response to the exceedingly wet conditions encountered by farmers during the harvesting of the 1985 crop, the following two major projects were initiated to help preserve the high quality and reputation of Canadian grain. To aid with the processing and testing of the thousands of samples involved, additional staff was hired on a temporary basis.

MONITORING OF ALPHA-AMYLASE LEVELS IN CARLOTS AND CARGOES OF CANADIAN WHEAT

Since wet harvesting conditions increase the risk of elevated alpha-amylase activity and sprout damage, it was decided to use the Falling Number test to monitor carlots of most classes and grades of wheat grown on the Canadian Prairies. This test is rapid and effective for detecting high levels of alpha-amylase activity - making it suitable for this purpose.

In order to identify areas shipping wheat of low Falling Number (high alpha-amylase activity), samples from a representative number of carlots originating from each Prairie station shipping wheat were tested. This information helped ensure that cargoes would not be loaded solely with wheat from a district exhibiting generally low Falling Number values.

A total of 13,143 samples representing 55,459 cars were tested. About 73% of the tests performed and 79% of the cars represented involved wheat of the Canada Western Red Spring (CWRS) class. Corresponding proportions for the Canada Western Amber Durum class, which accounted for the next higher numbers of samples and carlots represented, were 17% and 13%.

Cargoes of CWRS wheat loaded and exported from the Pacific ports are normally monitored on a quarterly-average basis. During the peak period of concern, this monitoring was increased to include testing of loading averages for individual cargoes and also testing, at an hourly frequency rate, of partial loadings of individual cargoes. This extensive exercise proved successful in helping to maintain Falling Number values at acceptable levels for the various grades of wheat shipped.

ASSESSMENT OF DAMAGE IN FARM-DRIED WHEAT

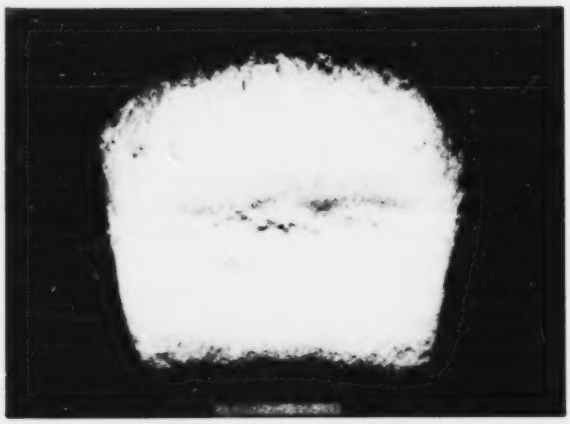
In late autumn of 1985, the Canadian Wheat Board estimated that approximately 40% of the western Canadian wheat crop was harvested in either a tough or damp condition and thus would require artificial drying in order to be stored safely. It was also estimated that about 40% of the wheat requiring drying would be of milling quality. Since terminal elevators do not have sufficient drier capacities to accommodate this volume of wheat quickly enough, it was expected that over 50% of the tough and damp wheat would be dried using heated-air grain driers situated on farms.

Through the Grain Research Laboratory, the Canadian Grain Commission offered a technical service to assist farmers in adjusting operating air temperatures within their driers to a safe level - thereby allowing wheat to be dried without irreversibly damaging its protein constituents and milling and baking quality. This concern over the proper use of grain driers was later justified since 42% of the first samples submitted from a specific drier exhibited seriously reduced or damaged quality as determined from an assessment of the mixing curves for a pair of "before drying" and "after drying" samples. The mixograph is used at the Laboratory to test the quality of farm-dried wheat and is performed on flour milled from the samples provided. This apparatus measures and records as a mixing curve the consistency of the dough being mixed. A change in mixing properties between "before" and "after" drying samples is directly related to a change in baking quality for such samples of the same originating wheat.

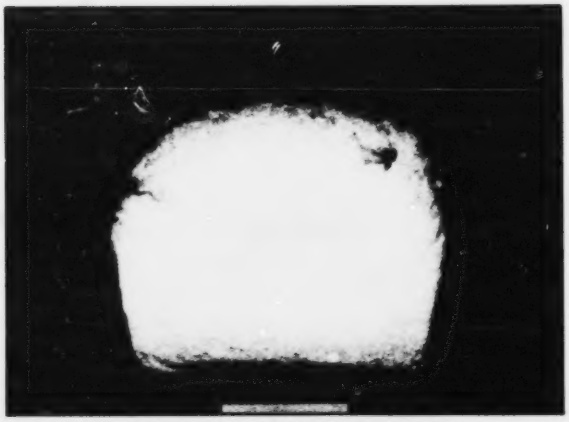
If "seriously reduced" or "damaged" quality was detected in the "after drying" sample, it was recommended to the drier operator that the temperature of the hot air be lowered and a further pair of samples be submitted for testing. This

process was repeated until a "satisfactory" quality result was obtained for the "after drying" sample.

Initially, this program also included testing of terminal-dried samples, and was later extended to include individual carlot and cargo samples submitted by the Inspection Division of the Canadian Grain Commission. Although from 2% to 30% of the samples tested in a given two-week period showed some degree of damage, no cargo sample yielded a result other than satisfactory.



Before Drying (Control)



After Drying (Quality Damaged)

An example of the effect of using improperly-dried wheat in breadmaking.

VARIETY STUDIES

The end-use quality evaluation of new cultivars of wheat, barley and oilseeds is an important part of the on-going program of the Research Laboratory. Results of this work are presented annually to the Expert Committee on Grain Quality which, together with the committees on Grain Breeding and Grain Diseases, carries out cultivar evaluation under the Canada Agriculture Services Co-ordinating Committee. New cultivars must meet certain minimum standards of agronomic performance, disease resistance and end-use quality before they are licensed in Canada for commercial production.

WHEAT CULTIVARS

In the last 5 years an average of 28 new cultivars in the red spring wheat breeding program have been evaluated annually for milling and baking quality. Of these, 5 have been licensed: Columbus, Lancer, Kenyon, BW 92 and BW 593.

In the amber durum wheat breeding program, an average of 15 new cultivars were tested annually for semolina milling and pasta making quality in the past 5 years. In this period, 4 new cultivars were licensed: Medora (1982), Arcola (1983), Kyle (1984) and Sceptre (1985).

The quality evaluation program at the Research Laboratory for the other classes of wheat is not as extensive as that for red spring and amber durum wheat. Milling properties are evaluated for all classes; a remix baking test is carried out for Canada Western Red Winter (CWRW) and Canada Prairie Spring (CPS) class samples; and a cookie test is performed for entries into the Canada Western Soft White Spring (CWSWS) class. In the past 5 years, HY320 was licensed in the CPS class; and although both varieties were developed in the USA, Norwin was licensed in the CWRW class and Owens in the CWSWS class.

The Research Laboratory again participated in an annual USA collaborative study to evaluate the milling and baking performance of spring and winter wheats. The study for red spring wheat was conducted by the Spring Wheat Quality Advisory Council and for red winter wheat by the Crop Quality Council.

THE ROLE OF THE GRAIN RESEARCH LABORATORY IN THE DEVELOPMENT OF CANADIAN MALTING BARLEY CULTIVARS

Emphasis in malting barley applied research is on advanced breeders' lines of barley intended for malting and brewing as opposed to breeders' lines suitable only for livestock feed. The principal programs leading to licensing of malting barley cultivars in Canada are the Western Co-operative Six-Row Barley Test and the Western Co-operative Two-Row Barley Test. To evaluate the quality of entries in these programs, the Grain Research Laboratory utilizes two sets of micromalting equipment - each designed to malt a minimum of 500 grams of barley. Entries in the Co-operative Barley Tests must perform successfully during three years of Co-operative testing in order to be considered for licensing.

Following one year of Co-operative testing, the most promising malting entries are advanced to Collaborative pilot-scale malting and brewing trials while still undergoing the second and third year of Co-operative testing. Collaborative trials are conducted jointly using the pilot-scale malting equipment of the Grain Research Laboratory, Canada Malting Co. Ltd. (Toronto), Dominion Malting Ltd. (Winnipeg) and the pilot-scale brewing facilities of the Brewing and Malting Barley Research Institute (Winnipeg), Labatt Brewing Co. Ltd. (London), Molson's Breweries of Canada Ltd. (Toronto) and Carling O'Keefe Breweries Ltd. (Toronto). Collaborative pilot-scale malting and brewing trials are grown at 4 or 5 locations yearly and require a minimum of 160 kg of barley of each selection from each location during two years of testing.

The Expert Committee on Grain Quality may decide to sup-

port an application for licensing of a barley selection as a malting cultivar after considering merit based on the testing outlined above. At this point, the breeder may apply to the Food Production and Marketing Branch of Agriculture Canada for a license. However, issuance of a license and naming of a malting variety is usually delayed for an additional 3 years until further railway carlot, commercial plant-scale tests are performed.

These latter tests involve close co-operation with SeCan Association and the Market Development Section of the Canadian Wheat Board. During the First year following support for licensing, SeCan Association contracts to grow about 500 kg of Select seed to produce about 35,000 kg of Foundation seed. During the second year, SeCan demotes most of this seed (33,000 kg) to Certified status to allow the Canadian Wheat Board to contract with 20 SeCan members to grow 60 acre fields each for market development programs. Meanwhile, SeCan use its remaining Foundation seed to produce about 65,000 kg of Registered seed. In the third year, most of this Registered seed is demoted to Certified status to allow the Canadian Wheat Board to contract with SeCan members to grow an additional forty 60-acre fields for additional market development programs. The Canadian Wheat Board guarantees to take delivery of all seed not utilized for market development programs during this phase of commercial testing. Also during this third year, SeCan contracts to produce about 250,000 kg of Foundation seed.

If Canadian Wheat Board programs prove successful, this Foundation seed will be released to SeCan members for seed increase during the fourth year following approval for licensing.

During the second and third years of the market development program, the Grain Research Laboratory monitors the quality of each contracted field in order to identify the best barley for commercial testing. The Brewing and Malting Barley Research Institute co-ordinates the delivery of this barley to the domestic malting companies and also determines the quantities of barley malt to be delivered to various domestic breweries. Some barley malt may also be exported to foreign breweries for their evaluation. Usually, from 4 to 6 carlots are evaluated during the second year of the market development program, and the number increases to 8 or 12 carlots during the third year of the program.

If the results of plant-scale malting and brewing trials are promising following three years of market development, a license is issued and the cultivar is given a varietal name. Otherwise, the breeder will withdraw the application for licensing, and Canadian Wheat Board and SeCan stocks of seed will be depleted by selling the grain for feed. The market development program ensures that potential malting cultivars will not come into commercial production until industry indicates approval and possible purchase of the seed when a variety is released.

OILSEED CULTIVARS

At the most recent meeting of the Expert Committee on Grain Quality, no new canola lines were supported for licensing, but the flax line FP 800 was supported. The non-canola rapeseed variety Tandem was granted a temporary license (one year duration) in July, 1985 - although support was originally not provided by the Oilseeds and Special Crop Subcommittee. In 1984, the canola variety Triton was licensed on the basis of its resistance to triazine herbicides, in spite of exhibiting low oil content and poor oil color. Other canola varieties licensed since 1980 include Tobin (1980), Andor (1981), Westar (1982), Global (1985), Hannah (1985), Pivot (1985), and Tribute (1986). Flax varieties licensed since 1980 include McGregor (1981), Norlin (1982), Norman (1984) and Vimr (1986).

RESEARCH AND QUALITY MONITORING PROGRAMS FOR OILSEEDS AT THE GRAIN RESEARCH LABORATORY

I. Introduction

Oilseeds are a group of crops whose common feature is that they are all commercially important sources of vegetable oil. The major Canadian oilseeds include canola (rapeseed), flaxseed (linseed), soybeans, and sunflowerseed. The annual farm-gate value of Canadian oilseed crops exceeds $1 billion, of which canola accounts for 65%-70%. Oilseeds account for about 17% of all grain-derived income in Canada (compared to 62% for wheat).

Except for flaxseed, oilseeds are relative newcomers to Canadian agriculture, having been introduced mainly during the Second World War when the Canadian government began a program to reduce Canada's dependence on imported sources of fats and oils. The program was so successful that Canada went from being a net importer of fats and oils to a major exporter of oilseeds in the space of 20 years.

The Canadian Grain Commission's mandate to ensure the quality of Canadian grain includes responsibility for oilseeds. The Grain Research Laboratory (GRL) has carried out studies on oilseeds since its establishment in 1913. In 1971, in recognition of the increasing importance of oilseeds in the export market and of the significant change in the quality of the most important oilseed export (rapeseed), a special section was established within the GRL to carry out studies on the quality of Canadian oilseeds.

Along with the crop monitoring program, the GRL has developed an ongoing program of applied research on oilseeds. This research has centered on the areas of analytical methods development, composition of oilseeds and end-products, and the effects of seed degrading factors on the quality of oilseeds and their products. This research has been carried out in support of both the monitoring programs and the grading system. Information from the research programs has assisted the Grain Inspection Division; has helped plant breeders to evaluate their varieties; and has provided information on the composition and quality of oilseeds and oilseed products to processors in Canada and to foreign customers. Analytical methods developed in the Oilseeds Section have been adopted as official methods by both national and international groups.

II. Research Activities

Research on oilseeds has taken place mainly during two distinct time periods. In the first period, lasting from 1913 until about 1940, the GRL was the major center for oilseeds quality research in Canada. This was especially true during the 1930's. In 1940, the Prairie Regional Laboratory was established by the National Research Council as the chemistry section of a center of excellence for oilseeds research in Saskatoon. At this time the GRL decreased its oilseeds research, maintaining only the routine monitoring programs and carrying out research only when dictated by grading problems.

The second period of research activity commenced in 1971 when the present Oilseeds Section was established to monitor the conversion of rapeseed from high erucic acid varieties to low erucic acid varieties. When the Prairie Regional Laboratory dropped its oilseed program in 1975, the GRL again became Canada's major center for research into the chemistry and quality of oilseeds.

II.A. Early Research

In the 1913 report of the Board of Grain Commissioners (now the Canadian Grain Commission) to the Ministry of Trade and Commerce, the chemist of the newly formed GRL was instructed to give studies on a flaxseed dockage problem a priority second only to grain moisture studies. Unfortunately, like many of the reports between 1913 and 1930, the results of this study have been lost. A list of titles of reports of flaxseed research carried out between 1913 and

1924 (Table 1) shows the beginnings of crop survey quality factor studies similar to those being carried out today.

Table 1. Reports Dealing with Flaxseed Research at the Grain Research Laboratory, 1913-1924[1]

Date	Title
April 2, 1917	Report on the oil content of flax from different grades.
December 21, 1917	Report on 1915-16 and 1916-17 crops of flax.
November 7, 1919	Oil content of flax by grades for the crop 1918-19.
March 27, 1920	Report on a sample of golden flax from Three Hills, Alta.
May 26, 1920	Report on oil content of spring threshed flax as received from the Chief Inspector.
June 11, 1920	Report re value of different grades of flax.
November 20, 1923	Report on percentage of oil and iodine number for different grades of Canadian flax.
August 9, 1924	Special report to Minister. Section on the "Grading of Flax"; also on "Moisture in Flax and its Relation to Heating".

[1] Reports were written by Dr. F.J. Birchard, first Chief Chemist of the Grain Research Laboratory.

When the Laboratory moved from its original location in the College of Agriculture to the Grain Exchange Building in 1930, the new facilities included equipment to carry out more extensive oilseed studies. Most of these studies were carried out by one junior chemist. During this time, regular quality surveys on flaxseed were initiated. Initial quality studies on sunflowerseed and safflowerseed (1936), mustard seed, both wild and domestic (1937), soybeans (1938), and *Peritome serrulata* (1938) were carried out as part of a project to develop new oilseed crops for Canada. Evaluation of the quality of new varieties of flaxseed being developed by Agriculture Canada plant breeders commenced in 1933 and continued as part of the Grain Research Laboratory's contribution to the National Research Council's Associate Committee on Grain Research (later the Canada Committee on Grain Quality and presently the Expert Committee on Grain Quality). Much of the research on flaxseed carried out in the 1930's was summarized in a series of 4 scientific publications in the Canadian Journal of Research (1-4). These papers provide examples of the combination of methodology studies, basic grading studies and compositional studies which have been found to provide the most useful information on the quality of oilseed crops.

Other research on flaxseed during the 1930's included investigations on the effect of weather damage (scabbing) on quality; the effect of drought and heat on iodine value; effect of drying temperature on quality; causes of poor germination; effect of fertilizer and irrigation on quality; effect of admixtures of *Camelina sativa* (false flax) on quality and preliminary studies on carotenoid pigments and cyanogenic glucosides. Commercial flax shipments from Argentina and the United States were evaluated and flaxseed production in the United States and Canada was summarized. The effect of environment on sunflowerseed quality was investigated and processing techniques for flaxseed and sunflowerseed were evaluated.

During the 1940's, Canada's research efforts to discover domestic sources of edible oils intensified. Overall dependence on imported oils and fats became of strategic importance when sources of overseas fats and oils were cut off by the war. The contribution to the search for domestic vegetable oils included a vegetable oils survey report which considered the possible use of flaxseed, sunflowerseed, waste seeds from fruit and vegetable processing, and grain screenings as sources of edible oils. In 1942 the junior chemist in charge of oilseeds was seconded to the Oils and Fats Administration for war work.

Research on oilseeds during the war years included further studies on flaxseed - such as the effects of fertilizer treatment, admixture with Lady's Thumb, rust, physical damage, broken wheat, and heat drying on quality, and changes in bushel weight due to handling. A summary of flaxseed survey studies was published (5). Work on sunflowerseed included artificial drying, a proposal for grading, and the effect of sunflower moth on quality. Manitoba grown soybeans were evaluated in 1942 and winter-threshed soybeans were evaluated in 1943. The first evaluation of the quality of Canadian grown rapeseed was performed in 1943.

By 1950, the activities of the GRL in the area of oilseeds had decreased to include only crop quality monitoring programs. Most quality-related oilseeds research in Canada between 1950 and 1970 was carried out either at Universities, the NRC's Prairie Regional Laboratory, or at the Agriculture Canada Research Stations at Saskatoon and Morden. Aside from a project on cyanogenic glucosides in frosted flax in 1954 and a project on the use of refractive index to determine iodine value of rapeseed oil in 1957, no research activities in the area of oilseeds occurred at the Grain Research Laboratory between 1950 and 1970. This meant that the GRL did not participate directly in the development of rapeseed as Canada's most important oilseed crop.

II.B. Recent and Current Research

By 1971, rapeseed had become a major crop in western Canada. At this time, the Canadian Grain Commission established a new section within the GRL to carry out oilseeds quality control and research. In particular, a major objective was to monitor the conversion of Canadian rapeseed from the old high erucic acid rapeseed (HEAR) types to the low erucic acid rapeseed (LEAR) varieties which had just been introduced. In 1970, the Canadian rapeseed industry, in consultation with the Health Protection Branch of the Department of Health and Welfare, had decided to make the switch to LEAR. This decision was based on findings that high dietary levels of erucic acid caused nutritional problems in animals and on an awareness of the growing importance of rapeseed oil in the Canadian market.

Gas chromatograph equipped with capillary columns and an automatic sampler/injector — for measurement of the fatty acid composition of oilseeds.

The new oilseeds section initially concentrated on monitoring the erucic acid levels in Canadian rapeseed. By 1975, the section had also taken on responsibility for other oilseeds monitoring programs which had, since 1950, been carried out by the analytical services section. One of the first achievements of the new oilseeds section was the successful development of a rapid procedure for estimating erucic acid in rapeseed (6). Work was also initiated on a method for determining glucosinolates.

Research efforts since 1975 have been divided into three major areas: methodology development, effects of degrading factors on quality, and an overall evaluation of quality in rapeseed, including the effects of weather and growing location. More recently, the section has expanded its research interests to include sunflowerseed and soybeans.

Methodology development has been of prime importance. Although standard procedures exist for most of the quality tests carried out on oilseeds, many of these are expensive, time-consuming, and cumbersome. Often these tests were designed for use in commercial testing laboratories or laboratories in developing countries which must carry out accurate and precise determinations using relatively inexpensive equipment. Much of the methodology development has centered on devising secondary procedures which utilize analytical instruments or semi-micro techniques. These allow more rapid analysis than the standard procedures but must be calibrated using the standard procedures. Examples of this type of methodology development include: the use of nuclear magnetic resonance spectroscopy to determine oil content, rapid transesterification of fatty acids, the use of fatty acid composition to determine iodine value, spectrophotometric and semi-micro titrimetric methods for determination of free fatty acids, titrimetric estimation of crude fibre, and the use of an oxygen bomb to prepare samples for phosphorus estimation. Many of the methods mentioned above have been found to be sufficiently rapid, accurate and precise to use in crop surveys.

Oxygen bomb used for burning oil samples prior to determining phosphorus content.

Sometimes there has been no suitable official method available for measuring a component of interest. For example, the measurement of glucosinolates in rapeseed became extremely important with the development of rapeseed varieties with low levels of these nutritionally undesirable compounds. Although an official ISO method was in existence, research at the GRL demonstrated that it was not sufficiently accurate to estimate the low levels of glucosinolates found in the new canola varieties. To overcome this difficulty, a method was developed, based on the best reported method from the scientific literature (7). This method has become the official method for estimating glucosinolates in canola. Similarly, no official method was available for the estimation of chlorophyll in rapeseed. A method was developed, again based on the best available method in the scien-

tific literature (8). From this method, a more rapid method using NIR technology has since been developed which has been found to be suitable for use at terminal elevator positions. The GRL has been active in arranging for acceptance of these analytical methods for glucosinolates and chlorophyll by the International Standards Organization. The GRL is also taking a leading role in the development of official analytical methods for canola and rapeseed by the American Oil Chemists' Society.

Measuring the chlorophyll content of rapeseed by NIR spectroscopy.

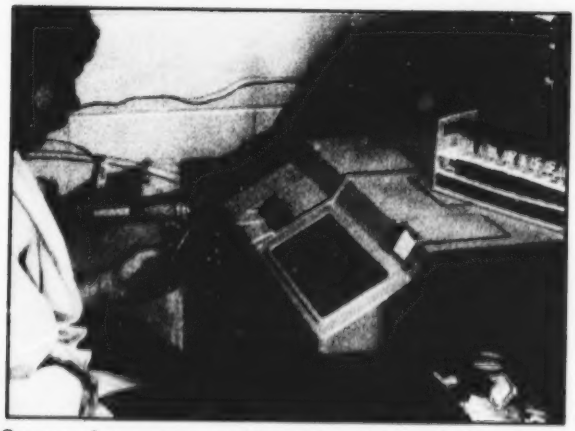
Grinding of a soybean sample prior to solvent extraction of the oil.

Weighing samples for oil content determination by solvent extraction.

Extraction apparatus used for the determination of oil content.

Along with their use in crop monitoring programs, methods developed in the oilseeds section have been used in studies on the effects of degrading factors on oilseed quality. The Canadian grain grading system relies on the visual assessment of degrading factors to segregate oilseeds according to quality. Studies on the effect of degrading factors on quality help in the continuing assessment of the grading system and also provide users of the oilseed with an evaluation of the quality of oil and meal to expect from samples with particular characteristics (9). Since 1975, studies on degrading factors in rapeseed have included green seeds (chlorophyll) (10), frost-damaged seeds (11), sprouted seeds (9), bin-heated seeds (9,12), admixtures with weed seeds (13) and, most recently, a study on the quality of over-wintered rapeseed (14). The topics of these rapeseed studies have been remarkably similar to the topics of flaxseed studies of the 1930's and 1940's. Indeed, a study carried out in 1977 on weather or scab damage to flaxseed (15) gave very similar results to a 1931 study on the same topic.

High-speed grinder used for pulverizing oilseeds prior to subsampling for various analytical tests.



Spectrophotometer used for chlorophyll and phosphorus analyses.

Chlorophyll or green seeds in rapeseed is a major degrading factor for this crop and has been a major topic of study since 1975. Along with the methodology development studies mentioned above, chlorophyll studies have resulted in better grading of rapeseed. Firstly, it was established that the 3% maximum for green seeds in No. 1 Canada rapeseed was too high to ensure that the seed would produce an acceptable oil. The tolerance was lowered to 2% in 1978. Further investigations revealed a very poor relationship between distinctly green seeds and chlorophyll, especially in the crucial 1% to 4% range of green seeds (10). As a result of these studies, inspectors have been encouraged to take account of the overall "good natural color" of the crushed sample in assessing the grade. This overall color evaluation has been especially important in years like 1985 when much immature rapeseed was harvested. These improvements in rapeseed grading have helped to ensure the quality of the product to overseas customers, with a resulting greater confidence in Canadian rapeseed by the export market, even in years with a poor average quality crop. The GRL has also taken part in a study in co-operation with the Canola Council of Canada to determine to what extent agronomic practices affect the chlorophyll level in rapeseed. This study showed that early planting, high seeding rate, and a minimum of 95 growing days would minimize the chlorophyll in *Brassica napus* grown in southern Manitoba (16).

Studies on overall quality have included such topics as the effect of species, variety and growing location on the iodine value, erucic acid (17,18), glucosinolate (19) and chlorophyll contents of rapeseed. These studies have involved the use of samples from crop monitoring programs as well as seed and oil samples collected from Canadian rapeseed crushing plants since 1979. Results from these studes have not only provided prospective customers with an overview of the quality of Canadian rapeseed but have also been used in setting standards. For example, results from a study on erucic acid (18) were used in setting the standard for erucic acid content when low erucic acid rapeseed was given GRAS ("generally recognized as safe") status in the United States. Similarly, results from studies on glucosinolate (19) content were used in setting the definition for canola. Results from chlorophyll, erucic acid and oil-sulfur studies were used in setting the new CGSB (Canadian General Standards Board) standard for oil quality. Most recently, results from varietal studies on glucosinolates have helped to point out a problem with the glucosinolate level in *B. campestris* varieties.

III. Liaison Activities

In recent years, the GRL has enjoyed a good working relationship with Canadian processors and with other research institutions. This relationship has seen the development of the seed and oil program described previously, as well as special studies such as on sulfur, and more recently, on phosphorus (20) in rapeseed and canola oil. The oilseeds section has provided standard samples of seed, especially for fatty acid composition, oil content, chlorophyll, and glucosinolate content to the crushing industry, to commercial testing laboratories, and to other researchers, especially plant breeders. Co-operative projects have been undertaken with the Agriculture Canada research station at Morden (flaxseed and sunflowerseed), with the Agriculture Canada research station at Saskatoon (rapeseed methodology and mustardseed) and with the Agriculture Canada research station in Winnipeg (rapeseed storage). Several joint projects, funded by the Canola Council of Canada's CUAP program have been carried out in conjunction with the University of Manitoba. More recently, methodology collaboration has extended overseas to France (Centre Technique Interprofessionnel des Oléagineux Metropolitains), and Japan (Japan Oilseed Processors Association).

The Grain Research Laboratory has maintained a presence in several national and international groups and organizations associated with oilseeds research. The activity started as early as 1934 when Dr. Geddes and Mr. Lehberg became chairman and secretary respectively of the Associate Committee on Grain Research's Subcommittee on Flax (later the Subcommittee on Oilseeds). A major role of this subcommittee, especially in recent years, has been to evaluate the quality of new varieties of oilseeds and provide support for their licensing in Canada where warranted. The Grain Research Laboratory has remained an active participant in the subcommittee up to the present time.

The GRL has also provided members to the NRC's Associate Committee on Fats and Oils. This committee was renamed the Expert Committee on Fats, Oils and Lipids under Agriculture Canada in 1985. The oilseeds section has also played an active role in CGSB standards committees on rapeseed oil and meal and more recently on canola oil and meal. Internationally, section head Dr. J.K. Daun is a member of the ISO's Technical Committee 34's Subcommittee on Oleaginous Seeds and Fruits; the American Oil Chemist's Society's Seed and Meal Analysis Committee; and the GCIRC's rapeseed analysis group. Work in these committees involves the elaboration of international standard methods of analysis for oilseeds and their products. At a more local level, membership in the Manitoba Sunflower Committee ensures the GRL a role in evaluating new sunflower hybrids.

IV. Crop Monitoring Programs

The Grain Research Laboratory has carried out yearly new crop surveys on flaxseed since 1932, on rapeseed since 1956, on Ontario soybeans since 1968 (except 1969), and on sunflowerseed since 1980. Surveys of railcar unloads at seaboard terminals for flaxseed have been undertaken since 1941 while flaxseed export shipments have been surveyed since 1946. Rapeseed railcar unloads and export shipments have been surveyed since 1957. Quality factors for sunflowerseed and mustardseed samples have also been reported on an occasional basis.

The new crop survey data for flaxseed show a wide variation in results from year to year, mainly due to environmental influences. This variation averages 0.85 and 1.45 percentage units for oil and protein content and about 3.4 units for iodine value. The presence of grain carried over from previous years in farmers' deliveries to country elevators tends to reduce year to year variation of carlot data and has an even more pronounced effect on cargo data. The average year to year variation in cargo data is only 0.46% for oil content, 0.91% for protein content and 2.4 units for iodine value.

Long term trends in flaxseed survey data (Figure 1) must be interpreted with caution as the effect of changes in methodology must be considered. For example, the earliest method for oil content determination utilized diethyl ether as an extracting solvent. This solvent has been shown to extract about 1% more oil than the currently used hexane or petroleum ether. Differences in grinding technique have also been shown to result in differences in oil content measurement. Differences between new-crop and cargo data may be influenced by the amount of dockage included in the analyzed sample. Protein content determinations in early years also gave higher results due to the use of different catalysts. It is generally recognized that protein results since about 1970 have been low by about 1.5% due to the discontinued use of mercury catalyst. Iodine values prior to about 1935 were about 5% low since the faster Hanus procedure was used up to that time. When these differences are taken into consideration, a long term trend toward higher oil content and iodine values and possibly lower protein content can be discerned. These changes reflect the success of the flaxseed breeding programs in assuring the role of Canadian flaxseed as a high quality product.

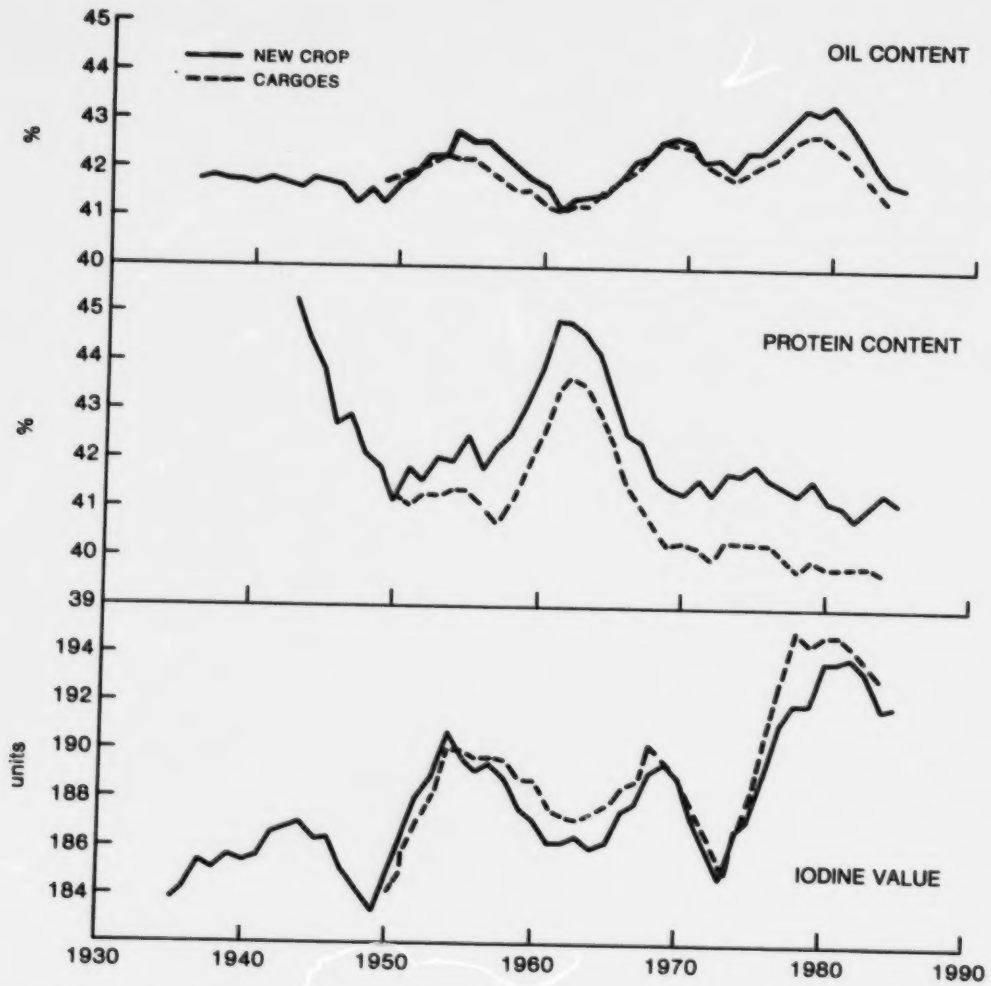


Figure 1
Five-year running averages of oil content (dry basis), protein content (oil-free, dry basis) and iodine value of western Canadian flaxseed from GRL surveys.

Similar trends can be seen for rapeseed (Figure 2). A general increase in oil content since 1960, accompanied by a decrease in protein content up to 1973, reflects the influence of the plant breeding program which emphasized selecting only for high oil content. Once plant breeders began to select for both high oil and high protein content, the overall quality of rapeseed improved. Quality improvements in rapeseed were not restricted to oil and protein content. Erucic acid (Figure 3) and glucosinolate content of Canadian rapeseed (Figure 4) have both been substantially reduced due to the efforts of plant breeders. Chlorophyll content of rapeseed seems to be mainly affected by environment. The overall chlorophyll content of rapeseed (Figure 5) has reflected the growing conditions of the year, being high in 1982 (early frost) and 1985 (cool wet harvest) and low in 1983 and 1984 (drought).

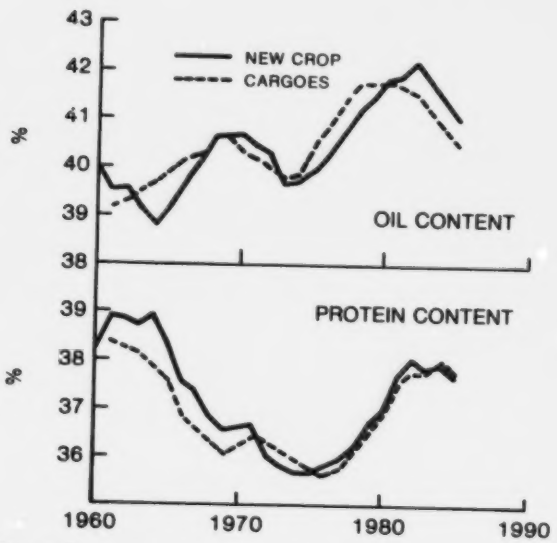


Figure 2
Five-year running averages of oil content (8.5% moisture basis) and protein content (oil-free, 8.5% moisture basis) of western Canadian rapeseed from GRL surveys.

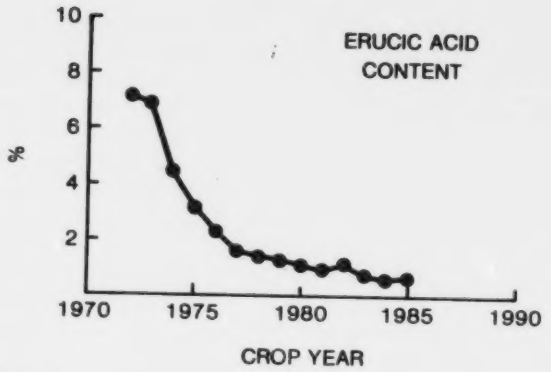


Figure 3
Erucic acid content of Canadian rapeseed from GRL new-crop surveys.

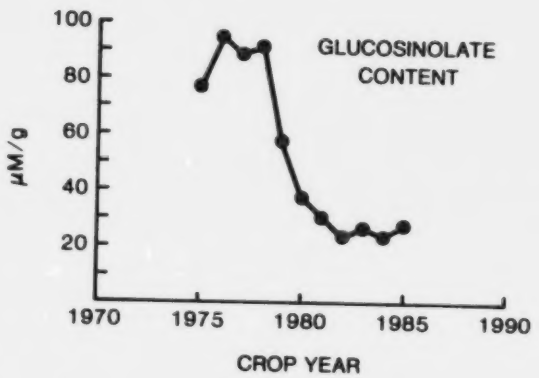


Figure 4
Glucosinolate content of Canadian rapeseed from GRL new-crop surveys.

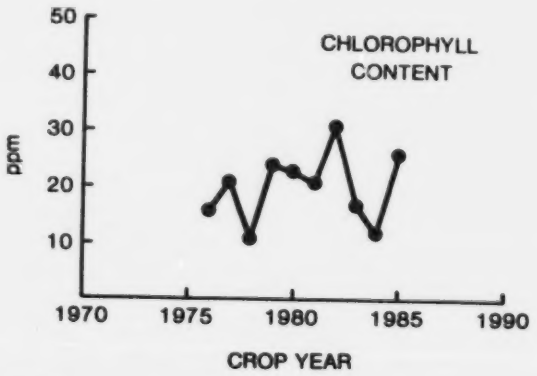


Figure 5
Chlorophyll content of Canadian rapeseed (all grades) from GRL new-crop surveys.

Other oilseed crop surveys have shown similar results. The oil content of sunflowerseed has increased from 30% to 45% with the introduction of the high oil content lines developed in Russia. The oil content of eastern Ontario soybeans has been remarkably constant at about 20% while the protein content, at 52% of the oil-free meal, is significantly higher than that of meal from United States grown soybeans. The protein content of Manitoba grown soybeans was found to be lower than that of soybeans grown in eastern Ontario but was significantly improved by the proper use of innoculation.

In addition to analytical results on the samples collected in crop monitoring surveys, the Grain Research Laboratory has published maps showing the origin of samples in both the carlot and new crop surveys. These maps have been useful both for indicating the sampling effectiveness of the new crop survey (Figure 6) and for indicating the growing area of crops. For example, Figure 7 shows the shifts in growth patterns for flaxseed at 10 year intervals since 1940 while Figure 8 gives a dramatic indication of the growth of rapeseed since 1956.

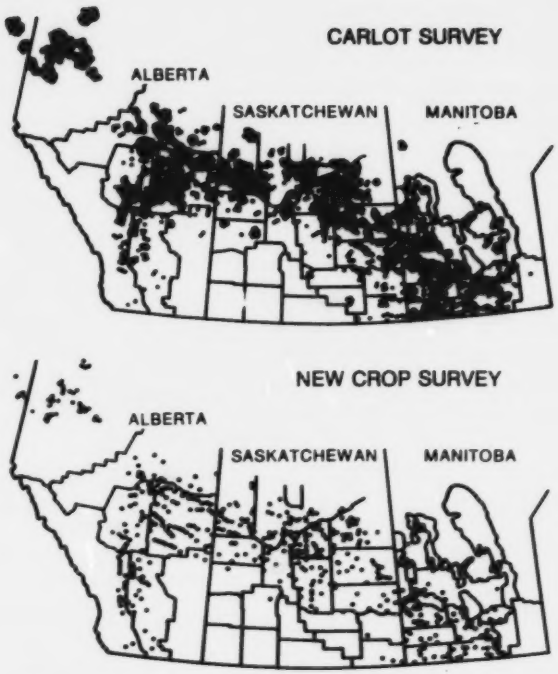


Figure 6
Origin of samples from 1968 carlot and new-crop surveys for rapeseed.

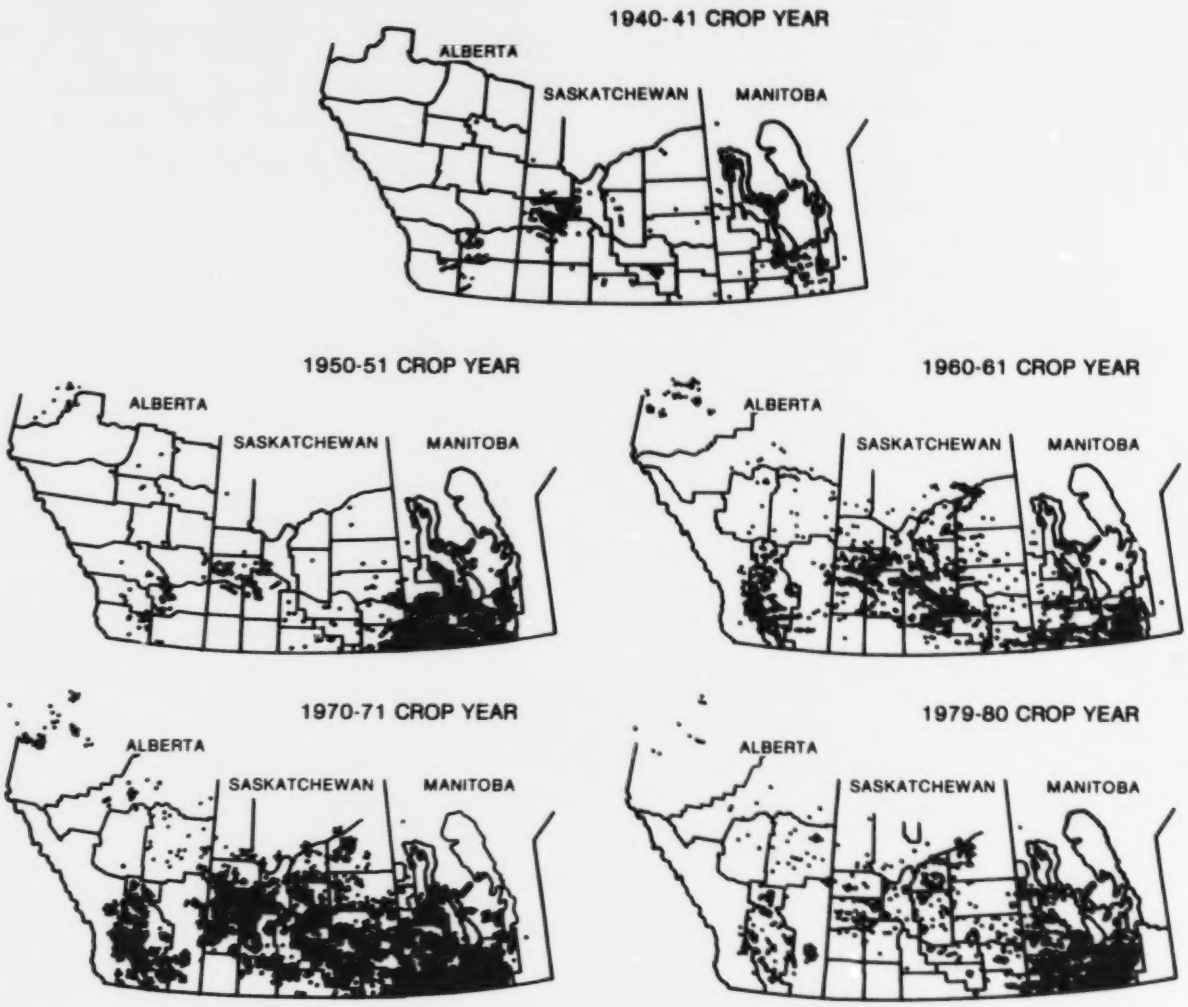


Figure 7
Map of western Canada showing the origin of flaxseed carlot samples from GRL surveys. Each dot represents five carlots, except for the 1940/41 and 1950/51 crop years where each dot represents one carlot.

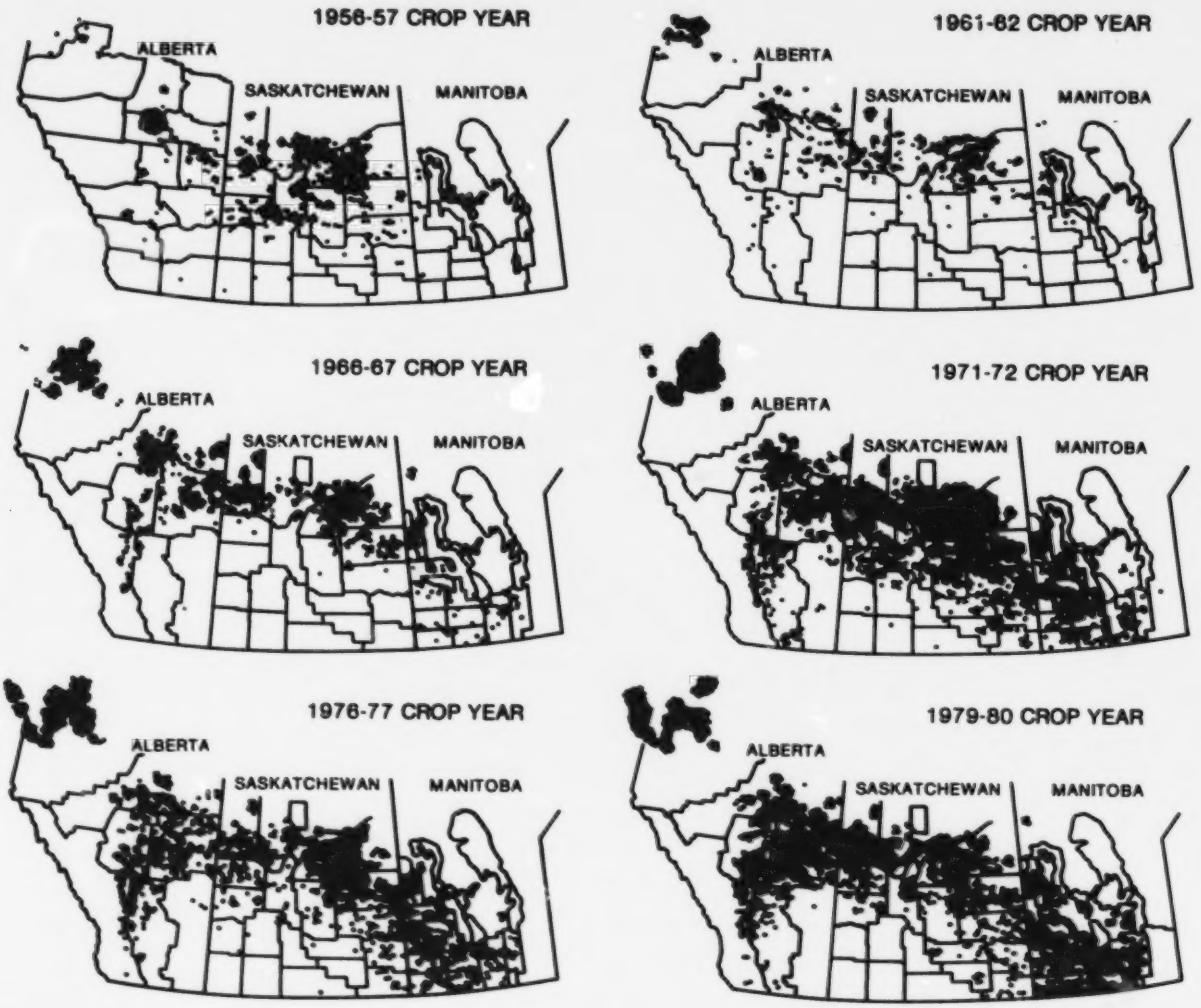


Figure 8
Map of western Canada showing the origin of rapeseed carlot samples from GRL surveys. Each dot represents five carlots, except for the 1956/57 crop year where each dot represents one carlot.

V. Future Research

Modifications to systems used for both crop monitoring and research programs will be made in the near future. The recent acquisition of automated chromatography equipment and a NIR analyser will allow more samples to be analyzed in crop surveys with a resulting greater confidence in the accuracy of the surveys. Rapid publication of this work will be aided by the use of computers to process the data. Interesting developments in crop types in the future include an edible oil flaxseed, and several different types of canola including: low linolenic acid lines, high palmitic acid lines, high linoleic acid lines, and canola mustard *(B. juncea)*. Development of high oleic acid sunflowerseed, and the possible development of safflowerseed as an oil crop will help shape an interesting future for quality monitoring.

Research will continue into methodology development concentrating on oil and protein content determination by NIR, new methods for glucosinolate analysis, and the development of an internationally acceptable analytical method for chlorophyll in rapeseed. Future quality factors of interest may include nitrogen solubility index for soybeans, cyanogenic glycosides in edible flax, phosphorus and sulfur in canola oils, and dehullability of sunflowerseeds. Investigations into the effects of degrading factors on end use quality will continue with an emphasis on green seeds (chlorophyll) in rapeseed. These investigations will center on the chemistry of chlorophyll and whether certain conditions lead to oils which are easy to bleach. The effect of degrading factors on storability of seeds and oils will be investigated.

The development of bench-scale processing of oilseeds is a long term research objective. Such a facility would allow better understanding of the effects that specific degrading factors have on oil quality. Useful information on crop quality could also be generated from such a facility. This would allow the GRL to actively continue in its role in support of the Canadian Grain Commission and the Canadian oilseeds industry through the evaluation of the quality of Canadian oilseeds.

High performance liquid chromatograph with microcomputer support for automated instrument control, data acquisition and generation of reports. Used to measure glucosinolate content of canola, as well as color and lipid components in oilseeds.

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LIAISON ACTIVITIES

VISITORS TO THE GRAIN RESEARCH LABORATORY

Each year, many people are accommodated on visits to the Research Laboratory. Visiting interest groups this year consisted of as many as fifty-five persons and included farmers, students, government employees, representatives of the grain trade, and technical and scientific personnel from Canada and abroad. Types of visits provided ranged from rapid and general tours of Laboratory facilities to detailed technical discussions with Laboratory scientists to collaborative research projects undertaken by Laboratory and non-Canadian Grain Commission scientists - using the facilities of the Grain Research Laboratory.

There were 54 visiting groups originating from within Canada, accounting for 618 visitors. In addition, a total of 188 people from outside Canada visited the Laboratory, with the following 23 countries being represented: Algeria, Australia, Denmark, Egypt, England, Ethiopia, Federal Republic of Germany, France, India, Israel, Italy, Japan, Korea, New Zealand, People's Republic of China, Peru, Portugal, Scotland, Singapore, South Africa, Syria, USA and Venezuela.

Mr. R. Brengman, owner of Old Fashioned Noodle Products, sought advice through the Canadian Food Products Development Centre on the proper drying of elbow macaroni (short goods). It was demonstrated to him that good results are attainable with the proper control of humidity and temperature.

Dr. D. Plett and Dr. A. Fowler, Alberta Agriculture, visited to consult with Dr. A.W. MacGregor, Ms. L. Cooke and an official of the Grain Inspection Division of the Canadian Grain Commission on the possibility of realizing a project on the digestibility and feeding value of frost-damaged and sprout-damaged wheat and barley. Dr. E.A. MacGregor completed a seven-month project while on sabbatical leave from the University of Manitoba, Chemistry Department. Dr. M. Scanlon, a graduate of Leeds University, England, completed a one-year appointment to a National Research Council of Canada visiting fellowship.

Three representatives (Wang De Fu, Hau Tian Liang, Xu Hui-Min) from the Import and Export Commodity Inspection Bureau (IECIB), People's Republic of China, received a rigorous, six-week "hands-on" training program, involving several of the Laboratory's quality-testing sections. Sufficient technical information was provided to help the IECIB achieve its objective of establishing quality control laboratories at Dalian and Shanghai.

A visit to the Oilseeds Section by representatives of food production, transportation and research activities in the People's Republic of China.

TECHNICAL VISITS

Again this year, scientists and technologists from the Grain Research Laboratory made numerous technical visits throughout the world - in support of market development and to maintain good contact and relationship with scientists and commercial processors in the field by exchanging information on current technological developments.

Dr. J. Kruger and Mr. L. Morris, together with staff from the Grain Inspection Division of the Canadian Grain Commission, spent one week at Vancouver presenting seminars for terminal elevator managers and operations staff. The main topic was the importance of proper binning of grain to help protect export markets from receipts of sprout-damaged wheat - particularly in years having a wet harvesting period.

Demonstration of the Falling Number test for detecting sprout damage. Presented during seminars at Vancouver for terminal elevator operations personnel.

During the 1985 harvest season, Mr. R.J. Wallis went to the Peace River area of Alberta to survey the accuracy of performance of Model 919 moisture meters located in primary elevators. Dr. P. Williams and Mr. W. Podolak travelled to grain company head offices in Regina and Calgary to discuss the Laboratory's acquisition of new-crop survey samples.

In November, Dr. K. Tipples travelled to Japan and Indonesia to promote Canada's recently-harvested grain crop; and Dr. J. Daun visited Japan to take part in consultations regarding the preliminary quality estimates for new-crop Canadian canola.

Dr. J. Kruger and Mr. D. Hatcher visited Waters Associates in Milford, MA to evaluate new developments in high performance liquid chromatography equipment and to involve the company's applications department in the Research Laboratory's computer software needs for cultivar identification by pattern recognition of wheat protein chromatographic profiles.

Dr. K. Preston spent three months in France studying the French milling and baking industry, with particular emphasis on the production of "pain français".

In September, Dr. J. Dexter journeyed to Korea as a member of a joint Canadian Wheat Board - Canadian Grain Commission - Canadian International Grains Institute mission to finalize plans and arrangements for a milling, baking and noodle manufacturing course.

Dr. K. Preston visited plant breeders in Swift Current, Lethbridge and Beaverlodge to discuss their breeding programs in general and the potential of new types and classes of wheat in particular.

Dr. R. Tkachuk called at several image analysis centres (Bethesda, Huntington and Argonne) to examine apparatus currently in use in this field with a view toward developing recommendations as to the possible applications of this powerful technique at the Grain Research Laboratory.

Dr. K. Preston and Mr. B. Morgan toured the Prairie Agricultural Machinery Institute at Humbolt, Saskatchewan and several grain drier installations near Saskatoon to discuss the safe farm-drying of wheat and inspect the types of farm driers popular today.

Dr. K. Tipples visited the Carlsberg Research Laboratories in Copenhagen, Denmark.

Dr. P. Williams was in Syria in conjunction with his ongoing technical consulting function for ICARDA.

Dr. R. Tkachuk visited the National Institute of Agricultural Botany and the Plant Breeding Institute, Cambridge, England to evaluate their wheat variety identification programs and relate them to Grain Research Laboratory procedures.

Dr. P. Williams formed part of a Canadian Wheat Board - Canadian Grain Commission team in Algeria to advise on correct processing conditions for a trial shipment of HY320 wheat.

Mr. G. Paulley studied and worked for one month at Warburton's Bakery, Bolton, England. This was part of an exchange program.

Dr. P. Williams visited the Pacific Scientific Corporation, Maryland to discuss the future of NIR technology applications in the agricultural and food industries.

In January, Dr. K. Preston and Dr. J. Dexter participated as technical consultants in a Canadian Wheat Board market development mission in Colombia - providing advice to Colombian millers and bakers on the use of Canadian milling wheat. They also visited pasta plants, mills and bakeries in Venezuela, which has recently become a significant importer of Canadian wheat.

CONFERENCE AND MEETING ATTENDANCE

Agriculture Canada
- Expert Committee on Fats and Oils
  - 1985 Meeting, Ottawa, Ontario ..... J.K. Daun
- Expert Committee on Grain Quality
  - 1986 Meeting, Winnipeg, Manitoba ..... L.D. Burch, J.K. Daun, D.R. DeClercq, D.E. LaBerge, A.W. MacGregor, R.R. Matsuo, K.R. Preston, R. Tkachuk, K.H. Tipples, P.C. Williams
- Information Systems Technology Meeting
  - Ottawa, Ontario ..... R. Tkachuk
- Western Computer Users Meeting
  - Banff, Alberta ..... R. Tkachuk

American Association of Cereal Chemists
- Annual Meeting, Orlando, Florida ..... J.E. Dexter, J.E. Kruger, A.W. MacGregor, B.A. Marchylo, K.R. Preston, K.H. Tipples, R. Tkachuk
- Milling and Baking Technical Conference
  - Cincinnati, Ohio ..... R.H. Kilborn

American Oil Chemists' Society
- Annual Meeting, Philadelphia, Pennsylvania ..... J.K. Daun

American Society of Brewing Chemists
- Annual Meeting, Milwaukee, Wisconsin ..... D.E. LaBerge

American Society of Plant Physiologists
- Annual Meeting, Providence, Rhode Island ..... A.W. MacGregor

Association of Official Analytical Chemists
- Annual Meeting, Washington, D.C ..... T.W. Nowicki

Association of Official Seed Analysts/Society of Commercial Seed Technologists
- Joint Meeting, Richmond, Virginia ..... L.A. Cooke

Association of Operative Millers
- Annual Conference, Cleveland, Ohio ..... D.G. Martin
- Joint Meeting with Canadian Prairie Section, AACC, Winnipeg, Manitoba ..... J.C. Babb, J.E. Dexter, A.W. MacGregor, B.A. Marchylo, R.R. Matsuo, L.A. Cooke, P.C. Williams

Barley Day Conference
- Grand Forks, North Dakota ..... D.E. LaBerge

Bionetwork
Inaugural Workshop on Amylases,
London, Ontario ..... D.E. LaBerge

Brewing and Malting Barley Research Institute
Technical Committee Meeting,
Winnipeg, Manitoba ..... D.E. LaBerge

Canola Industry and Research Personnel Meeting
Saskatoon, Saskatchewan ..... J.K. Daun

Codex Alimentarius Commission
Sixteenth Session, Geneva, Switzerland ..... R. Tkachuk

Crop Quality Council Meeting
Manhattan, Kansas ..... K.R. Preston

Fourth International Symposium on Pre-Harvest Sprouting
Port MacQuarrie, Australia ..... J.E. Kruger
B.A. Marchylo

Grain Marketing Summit
Lake Louise, Alberta ..... K.H. Tipples

International Association for Cereal Chemistry
Symposium and Executive
Committee Meeting ..... K.H. Tipples

International Baking Industry Exposition
Las Vegas, Neveda ..... R.H. Kilborn

International Conference on Macromolecular
Structure and Function
Tokorozawa, Japan ..... R. Tkachuk

International Standards Association Meeting
Paris, France ..... J.K. Daun

International Symposium on Durum Wheat
Foggia, Italy ..... R.R. Matsuo

Maltsters' Conference
Eagle Lake, Ontario ..... A.W. MacGregor

Manitoba Insitute of Agrologists
Annual Meeting, Winnipeg, Manitoba ..... L.A. Cooke

Master Brewers' Association of the Americas
Annual Meeting, Seattle, Washington ..... D.E. LaBerge
Western Canada District
Annual Meeting, Edmonton, Alberta ..... D.E. LaBerge

National Conference on Weights and Measures
Annual Meeting, Washington, D.C. ..... C.J. Dempster

NC-151 Workshop on Technology
Grain Quality Evaluation, Toledo, Ohio ..... C.J. Dempster

Phytopathological Society
Annual Meeting, London, Ontario ..... R.M. Clear

Process Control and Quality Assurance Workshop
Winnipeg, Manitoba ..... J.C. Babb

Spring Wheat Quality Advisory Council Meeting
Fargo, North Dakota ..... K.R. Preston
K.H. Tipples

Starch Science and Technology Conference
Orlando, Florida ..... A.W. MacGregor

Statistical Association of Manitoba
Annual Meeting, Winnipeg, Manitoba ..... J.C. Babb

Statistical Quality Control Advances Conference
Winnipeg, Manitoba ..... J.C. Babb

Statistical Society of Canada
Annual Meeting, Winnipeg, Manitoba ..... J.C. Babb
Western Canada Pesticide Analysts
Annual Workshop, Winnipeg, Manitoba ..... T.W. Nowicki (Chairman)
J.W. Thorsteinson

COMMITTEE MEMBERSHIP

Canadian Grain Commission
Eastern and Western Grain
Standards Committees ..... K.H. Tipples
Agriculture Canada
Canada Committee on Crop Production
Services ..... K.H. Tipples
Expert Committee on Fats and Oils ..... J.K. Daun
Expert Committee on Grain Quality ..... K.H. Tipples (Chairman)
R. Tkachuk
Subcommittee on Barley ..... D.E. LaBerge (Chairman)
A.W. MacGregor
Subcommittee on Oilseeds ..... J.K. Daun (Secretary)
L.D. Burch
Subcommittee on Wheat ..... R.R. Matsuo (Chairman)
K.R. Preston (Secretary)
K.H. Tipples
P.C. Williams
Agricultural Institute of Canada
Associate Editor, Canadian Journal of
Plant Science ..... R.R. Matsuo
American Association of Cereal Chemists
Technical Committees:
Amylase Methods ..... J.E. Kruger
A.W. MacGregor
Bread Baking Methods ..... R.H. Kilborn
K.R. Preston
Experimental Milling ..... J.E. Dexter
Methods for Grain Testing ..... P.C. Williams
Near-Infrared Reflectance ..... P.C. Williams
Pasta Products Analysis ..... J.E. Dexter
R.R. Matsuo
Physical Testing Methods ..... R.H. Kilborn
K.R. Preston
Quality Tests for Wheat and Flour ..... R. Tkachuk
Canadian Prairie Section ..... J.E. Dexter (Chairman)
B.A. Marchylo (Vice-Chairman)
L.A. Cooke (Secretary-
Treasurer)
Publications Committee ..... J.E. Kruger
Board of Editors, Cereal Chemistry ..... J.E. Dexter
American Oil Chemists' Society
Seed and Meal Analysis Committee
Subcommittee on Rapeseed and
Safflowerseed ..... J.K. Daun (Chairman)
Brewing and Malting Barley Research Institute
Technical Committee ..... D.E. LaBerge

Canadian General Standards Board
- Committee on Bakery and Cereal Products . . . . . R.R. Matsuo
- Committee on Canola Oil . . . . . J.K. Daun
- Committee on Canola Meal . . . . . J.K. Daun

Canadian Government Interdepartmental
- PCB Committee . . . . . T.W. Nowicki

Codex Alimentarius Commission, FAO, WHO
- Canadian Delegation . . . . . R. Tkachuk (Chairman)

Federal Interdepartmental Committee on
- Pesticides Check Sample Program: Feeds/Grains Sub-program . . . . . T.W. Nowicki (Co-ordinator)

International Association for Cereal Chemistry
- Executive Committee, Technical Committee and General Assembly . . . . . K.H. Tipples
- Working Groups on:
  - Variety Identification by Electrophoresis . . . . . R. Tkachuk
  - Baking Tests . . . . . K.H. Tipples (Chairman)
  - Determination of Wet Gluten . . . . . K.R. Preston
  - Particle Size . . . . . P.C. Williams
  - Methods of Protein Determination . . . . . R. Tkachuk
  - Sampling . . . . . P.C. Williams
  - Near-Infrared Technology . . . . . P.C. Williams

International Standards Organization
- Canadian Advisory Committee TC34/SC4 . . . . . K.H. Tipples (Chairman)
- Canadian Advisory Committee TC34/SC2 . . . . . J.K. Daun

Manitoba Sunflower Committee . . . . . J.K. Daun

Red River Community College
- Advisory Committee for Chemistry and Biochemical Technology . . . . . R. Tkachuk

Statistical Association of Manitoba . . . . . J.C. Babb (President)

University of Manitoba
- Adjunct Professors, Department of Plant Science . . . . . A.W. MacGregor, R. Tkachuk, P.C. Williams

The 1985 meeting of the Western Grain Standards Committee.

PUBLICATIONS

SCIENTIFIC PAPERS

525 DAUN, J.K., MILLS, J.T., CLEAR, K.M. Storability of Frost Damaged Canola. Canadian J. Plant Sci. 64:529-536, 1984.

529 YOUNG, J.C., FULCHER, R.G., HAYHOE, J.H., SCOTT, P.M., DEXTER, J.E. Effect of Milling and Baking on Deoxynivalenol (Vomitoxin) Content of Eastern Canadian Wheats. J. Agric. Food Chem. 32(3):659-664, 1984.

535 MACGREGOR, A.W., MACGREGOR, E.A. The Action of Cereal Alpha-Amylases on Solubilized Starch and Cereal Starch Granules. In *Proceedings of the International Conference on New Approaches to Research on Cereal Carbohydrates*, Copenhagen, Denmark, 149-160, 1984.

539 LENOIR, P., MACGREGOR, A.W., MOLL, M., DAUSSANT, J. "Physiologie Végétale". Identification de la R-enzyme de l'orge et du malt par focalisation isoélectrique. C.R. Acad. Sc. Paris T. 298, Série III, N° 8.

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CHAPTERS IN BOOKS

BURGER, W.C., LABERGE, D.E. Malting and Brewing Quality. In *Barley* (Agronomy Monograph No. 26) published by the American Society of Agronomy Inc., the Crop Science Society of America Inc. and the Soil Science Society of America Inc., 1985. Pages 367 to 401.

PERIODICAL PUBLICATIONS

Fifty-eighth Annual Report

1984-1985 Report of the Grain Research Laboratory

Crop Bulletins and Map

Map of Western Canada showing the protein content distribution of all grades of Canada Western Red Spring wheat for the 1985 crop.

166 - Quality of 1985 Canadian Wheat

167 - Western Canadian Oilseeds 1985

Quality of Western Canadian Rapessed and Flaxseed, 1985 New Crop, Preliminary Report

Quality of Western Canadian Rapeseed, 1985 New Crop, Final Report

Quality of Western Canadian Flaxseed, 1985 New Crop, Final Report

Quality of 1985 Canadian Soybean Crop

Cargo Bulletins

Red Spring Wheat editions are published in an English-French-German-Spanish version, an English-Japanese version (suffix "J") and an English-Chinese version (suffix "C"). Amber Durum Wheat editions are published in an English-French-German-Italian version.

224 Quality of Canadian Grain Exports 1984-1985, Red Spring Wheat, second quarter (Nov. 1 to Jan. 31)

225 Quality of Canadian Grain Exports 1984-1985, Amber Durum Wheat, first and second quarters (Aug. 1 to Jan. 31)

226 Quality of Canadian Grain Exports 1984-1985, Red Spring Wheat, third quarter (Feb. 1 to Apr. 30)

227 Quality of Canadian Grain Exports 1984-1985, Red Spring Wheat, fourth quarter (May 1 to July 31)

228 Quality of Canadian Grain Exports 1984-1985, Amber Durum Wheat, third and fourth quarters (Feb. 1 to July 31)

Quality of Canadian Rapeseed and Flaxseed Cargoes, 1984-1985 Crop Year

229 Quality of Canadian Grain Exports 1985-1986, Red Spring Wheat, first quarter (Aug. 1 to Oct. 31)

ORAL PRESENTATIONS

At Canadian International Grains Institute

K.H. Tipples
- Introduction to the Grain Research Laboratory (presented twice)

J.K. Daun
- An Examination of the Effects of Grading Factors on End-use Quality of Oilseed Products
- Introduction to the Grain Research Laboratory (presented twice)
- An Examination of Oil Extraction, Refining of Oils for Specific Applications and Processing of Meal

J.E. Dexter
- Experimental Milling
- The Theory of Experimental Milling
- Relation of Wheat Class and Grade to End-use Quality
- An Examination of the Effects of Grading Factors on End-use Quality of Different Classes of Wheat

J.E. Kruger
- Development of New Wheat Varieties in Canada: Screening for End-use Quality

D.E. LaBerge
- Introduction to the Grain Research Laboratory
- Effect of Grading Factors on End-use Quality of Malting Barley

A.W. MacGregor
- Biochemistry of Malting
- Recent Research in Malting
- An Examination of How Degrading Factors Affect the End-use Quality of Barley

R.R. Matsuo
- Pasta Goods Manufacturing
- Effects of Degrading Factors on Durum Wheat Utilization

R.R. Matsuo and K.R. Preston
- Canadian Wheat Quality: A Review
- Canadian Wheat: Properties, Functionality and End-uses

K.R. Preston
- Types and End-uses of Flour

R. Tkachuk
- Screening for End-use Quality

P.C. Williams
- Wheat: Properties, Functionality and End-uses
- Effects of Degrading Factors on Spring and Winter Wheat Utilization

At Conferences, Meetings and Seminars

K.H. Tipples
- Philosophy of Test Baking. International Association for Cereal Chemistry Symposium, Oslo, Norway

J.C. Babb
- Multicolinearity in Applied Regression Analysis. Workshop presented at the Canadian Grain Commission, Winnipeg
- Linear Regression Analysis and SIGSTAT. Workshop presented at the Canadian Grain Commission, Winnipeg

R.M. Clear and L.A. Cooke
- Pink Discoloration in Grain. American Association of Cereal Chemistry (AACC), Canadian Prairie Section, Winnipeg, MB

L.A. Cooke
- Pink and Red Discolorations in Grain. Grain Inspector's Seminar No. 2, Canadian Grain Commission, Winnipeg, MB

J.K. Daun
- Quality Characteristics Associated with the Seed Coat Color of Canola. Annual Meeting, American Oil Chemists' Society, Philadelphia, PA

J.E. Dexter
- The Importance of Lipids in Determining Spaghetti Cooking Quality. Annual Meeting, AACC, Orlando, Florida

J.E. Kruger
- The Mobilization of Endosperm Reserves During Germination
- The Monitoring System for Sprout Damage in Canada
- Nephelometric Determination of Alpha-amylase.

These three papers were presented at the Fourth International Symposium on Pre-Harvest Sprouting, Port MacQuarrie, Australia

D.E. LaBerge

Changes in Beta-amylase Enzymes During Kernel Development of Barley and the Effect of Papain as an Extraciant. Annual Meeting, American Society of Brewing Chemists, Milwaukee, Wis.

Starch Degrading Enzymes in Barley and Malt. Inaugural Workshop on Amylases, Bionetwork, London, Ont.

A.W. MacGregor

Contribution of the Embryo to the Synthesis of Alpha-amylase in Germinating Barley. Starch Science and Technology Conference, Orlando, Florida

Hydrolysis of Barley Starch Granules by Alpha-amylases from Barley Malt. Annual Meeting, AACC, Orlando, Florida

Changes in Barley Kernels During Maturation and Malting. Maltsters' Conference, Canada Malting Co., Eagle Lake, Ont.

Alpha-glucosidase in Barley and Malt. Poster presentation, Annual Meeting, American Society of Plant Physiologists, Providence, RI.

Structure of Cereal Grains and Biochemistry of Barley and Malt. Department of Food Science, University of Wisconsin.

Six lectures on barley production and utilization. Department of Plant Science, University of Manitoba.

B.A. Marchylo

Comparison of Proteins Separated by Reversed-phase HPLC, at Different Stages of Malting, for Two Barley Cultivars of Contrasting Malting Qualtiy. Annual Meeting, AACC, Orlando, Florida.

Wheat Cultivar Identification by Reversed-phase HPLC. Tenth Joint Conference, Association of Operative Millers/American Association of Cereal Chemists (AOM/AACC), Winnipeg, MB.

Degradation of Starch Granules in Maturing Wheat and Its Relationship to Alpha-amylase Production by the Embryo. Fourth International Symposium on Pre-harvest Sprouting, Port MacQuarrie, Australia.

Quantitation Analysis of Multiple Forms of Alpha-amylase Produced in Germinating Cereals. Fourth International Symposium on Pre-harvest Sprouting, Port MacQuarrie, Australia.

R.R. Matsuo

Durum Wheat Gluten: *Non Multa Sed Multum*. International Symposium on Durum Wheat, Foggia, Italy.

Durum Wheat: Processing and End Uses. Three lectures presented at the Department of Plant Science, University of Manitoba.

How the Rapidly Evolving Wheat Industry in the People's Republic of China Might Affect Canada's Wheat Trade. Tenth Joint Conference, AOM/AACC, Winnipeg, MB.

T.W. Nowicki

Confirmation of Seed Treatment Pesticides in Grain Using the Mass Selective Detector (MSD). Annual Workshop, Western Canada Pesticide Residue Analysts, Winnipeg, MB.

K.R. Preston

Description and Application of Instrumentation for the Study of Bread Processing at the Grain Research Laboratory. Annual Meeting, AACC, Orlando, Florida.

R. Tkachuk

Prediction of Amino Acid Levels in Field Peas by NIR Diffuse Reflectance Spectroscopy. Annual Meeting, AACC, Orlando, Florida.

Protein, Moisture and Chlorophyll Analysis with a Six Filter VIS/NIR Instrument. Annual Meeting, AACC, Orlando, Florida.

Near Infrared Reflectance Spectroscopy Techniques. Three lectures presented at the Department of Plant Science, University of Manitoba.

Measurement of Chlorophyll in Rapeseed. A seminar presented at the Canadian Grain Commission, Winnipeg.

Amino Acid Analysis of Grain by a Near-infrared Reflectance Technique. Third USA-Japan Protein Conference, Tokyo, Japan.

P.C. Williams

The Canadian Flour Mill Kjeldahl Protein Check Sample. Tenth Joint Conference, AOM/AACC, Winnipeg, Manitoba.

Near-infrared Technology. Lecture presented to an AACC Short Course, Chicago, Illinois.

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